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America's First Aeronautical Magazine

AVIATION

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McGRAW-HILL
UBLISHING COMPANY, INC.

AVIATION

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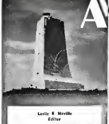

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Volume 45 • No 8

Like a lot of others, we got pretty badly confused by the varied and conflicting reports emanating right after the "Able Day" atom bomb test at Bikini, so it was with more than a feeling of relief that we received the sober, reasoned reports of our own correspondents on the spot. The revolutionary effects the A-bomb will have on aircraft design, operation, and maintenance, are carefully analyzed by Scholer Bangs—making "must" reading for everyone in the aviation industry. And how this new air weapon will change surface vessel design and tactical concepts is detailed by Phil Swain, editor of McGraw-Hill's magazine *Power* and a very well informed authority on atomic energy. These two stories (on pages 38 and 41, respectively) back up Les Neville's thought-provoking editorial on page 37.

There's a new trend just beginning to show up in airline maintenance—through factory-directed service and overhaul bases. Getting away to a fast start in this field is Lockheed, and how it is establishing a worldwide network of such bases for both airline and individual-owner service—no matter whose planes are involved—is given in the article beginning on page 44.

Do you have a four-place completely instrumented plane that will cruise 150 mph for 500 mi., that you'll sell for \$1,500 to \$2,000? If you haven't, maybe you'll want to start an industry-wide program designed to educate John Q Public as to just what he can expect for his airplane dollar—which certainly won't get him everything he expects today. Just how big and important this job will be is clearly indicated by the facts (page 42) brought out by a nation wide survey which shows what the average American wants in his personal plane.

In Dutch Kindelberger's office at North American there is a framed motto which says:

"It may not always be the best policy to adopt the course that is best technically, but those responsible for policy can never form a right judgment without knowledge of what is right technically."

This is a policy with which we agree heartily, and which we have tried through the years to maintain. When we asked Dutch who first expressed it, he said he wasn't sure; he'd heard it attributed to C. W. Kettering. Anyone know the author?

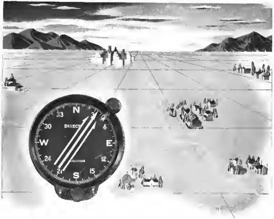
FRED CHARLES BRETCHER (left), co-pilot, and Max Stanley (center) pilot, of XB-35 Flying Wing superbomber, check with head-man, John K. Northrop (right) just before taking the giant craft aloft on its first test flight. Shortly thereafter—over the July Fourth holiday to be precise—Jack Northrop wrote his own story of this great flying wing in time for this issue. It continues the series he has written exclusively for Aviation on his all wing planes and heads up a special section devoted to flying wings, covering also the Vought XF5U-1, the de Havilland jet-powered 108, the Armstrong Whitworth 52G, and the first complete roundup of the twelve projects undertaken in Germany by the Horten brothers.

Down the Years in AVIATION'S Log

25 Yr. Ago (1921)—*Oregon Journal* uses Curtiss Seagull to carry newspapers to neighboring cities. . . . Adm. Moffatt becomes first "Air Admiral" and organizes Navy Aviation branch. . . . Army stages sham bombing attacks on New York, Washington, and Richmond. . . . Chicago-Minneapolis airmail suspended for lack of funds. . . . Canada inaugurates aerial fire patrol in B. C., using HS-2-L flying boats. . . . Pilot Kirch, at Versailles, breaks altitude record at 32,889 ft. . . . First free balloon flight made in Philippines by U. S. Army. . . . Canadian Customs uses aircraft to prevent smuggling. . . . Bolivian Government starts aviation school. . . . First trans-Andean passenger carrying flight made in de Havilland by Chilean Army officers. . . . Eighteen U. S. colleges now give courses in aeronautics. . . . Airplane passenger service started between Paris and Le Havre.

15 Yr. Ago (1931) — Lockheed Altair with retractable landing gear flies 1,300 mi. from Vancouver to Mexico in 7 hr. 48 min., breaking record by 1 hr. 26 min. . . . Post and Gatty fly around world in 8 days, 15 hr., 51 min. . . . D. of C. names air traffic control committee. . . . TWA moves base to Kansas City. . . . Navy's new rigid airship *Akron* takes air on Aug. 8. . . . Amelia Earhart flies autogiro 11,000 mi. in 150 hr. . . . Kronfeld glides non stop from England across Channel to France and back. . . . Florida legislature authorizes state sponsored landing strips paralleling roads. . . . State of Michigan forbids erection of obstructions near airports and orders marking of present structures. . . . SAE adopts AN standards for aircraft and engine fittings. . . . Venezuelan oil company uses Sikorsky Amphibion for oilfield surveys.

10 Yr. Ago (1936)—Henry Wightman glides 135 mi. airline distance at Elmira winning Toledo Trophy. . . . Delta Air Lines reports less than 1% lost time. . . . Lockheed 12, eight passenger feeder-liner, placed on market. . . . French government offers 10,000,000 francs for design of Diesel engine capable of flying Atlantic. . . . Panagra starts N. Y.-Buenos Aires service. . . . PAA announces twice weekly service to Rio. . . . French Chargeurs Reunis Co. orders three Sikorsky S-43 Amphibions for West African service. . . . Army projects air base in Alaska. . . . Imperial Airways and PAA announce Bermuda service. . . . Navy orders 50 Consolidated flying boat patrol bombers, 191 dive bombers from Curtiss, Vought, and Northrop, and 60 Consolidated XP3Y flying boats.



The Kollsman Direction Indicator
...the compass that works with you!

The Kollsman Direction Indicator — widely used in private planes and in an increasing number of scheduled airline operations — is regarded by many pilots as one of the greatest aids to the ease, enjoyment and safety of cross-country flying.

The 360° compass rose dial is similar in appearance to the rose on all aviation charts. With the compass pointer continually showing the course being flown and the auxiliary "memo" pointer set to the course desired, you are given a continuous "picture" of your flight.

The performance of the direct-reading Kollsman Direction Indicator is another big reason for its popularity. The pointer moves quickly to a new heading and remains "steady," without oscillation or appreciable overswing — the result of a unique vane dampener construction which is a special feature of this Kollsman unit.

To the more advanced pilot the Direction Indicator offers special advantages. For "approach procedures," for instance, the relationship between other headings and the runway designated for landing is instantly apparent. "Reciprocal" headings and relationship to other beams can be quickly seen and the possibility of error greatly reduced.

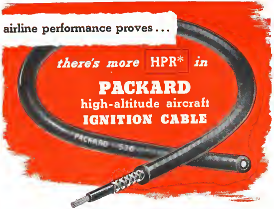
For an illustrated folder giving complete details, write Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, New York.

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

SQUARE D COMPANY

ELMHURST, NEW YORK • GLENDALE, CALIFORNIA



More Hours Per Replacement... that's the plus-performance factor that makes Packard high-altitude aircraft ignition cable the choice of leading airlines. This better-designed, better-built cable utilizes modern materials and advanced manufacturing methods to provide an extra margin of safety under the most adverse operating conditions. Standardize on Packard high-altitude aircraft ignition cable for greater mechanical and dielectric strength, greater resistance to heat, cold, oil, moisture and abrasion. It gives more HPR... more hours per replacement... in commercial, military and private planes.

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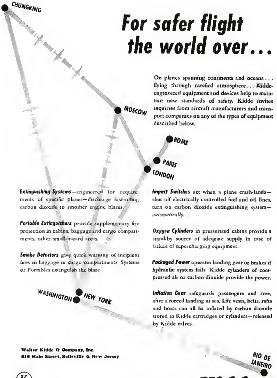

For safer flight the world over...

On planes spanning continents and oceans... flying through rarefied atmosphere... Kidde-engineered equipment and devices help to maintain new standards of safety. Kidde invites inquiries from aircraft manufacturers and transport companies on any of the types of equipment described below.

Extinguishing Systems—engineered for requirements of specific planes—discharge fast-acting carbon dioxide to smother engine blazes.

Portable Extinguishers provide supplementary fire protection in cabins, baggage and cargo compartments, other small-hazard areas.

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Impact Switches act when a plane crash-lands—shut off electrically controlled fuel and oil lines, turn on carbon dioxide extinguishing system—*automatically*

Oxygen Cylinders in pressurized cabins provide a stand-by source of adequate supply in case of failure of supercharging equipment.

Packaged Power operates landing gear or brakes if hydraulic system fails Kidde cylinders of compressed air or carbon dioxide provide the power.

Inflation Gear safeguards passengers and crew after a forced landing at sea. Life vests, belts, rafts and boats can all be inflated by carbon dioxide stored in Kidde cartridges or cylinders—released by Kidde valves

Walter Kidde & Company, Inc.
818 Main Street, Belleville 9, New Jersey

Kidde

When History Repeats Itself....

PONCE DE LEON won't waste a lifetime on a wild goose chase... he'll *FLY* to the Land of "Bimini"!

Juan Ponce de Leon never found the Fountain of Youth, although he spent most of his life looking for it. What's more, he always believed that Florida was an island! Today, in a sleek Luscombe Silvaire, Juan could fly cross the Florida peninsula in less than an hour, learning that the land he discovered was not an island and that the exhilaration and feel of freedom that only air travel provides is about the closest approach to a Fountain of Youth this old world has ever seen.

Much of the popularity of personal flying lies in its invigorating freedom — the feeling of release from all things earth-bound. Likewise, no small part of the progress that has marked the development of U.S.-built planes—whether single-seaters or gigantic transports—can be traced to the strength-without-weight advantages that OSTUCO Steel Tubing provides. The continued development of American aircraft, resulting in faster, safer, more economical flying in the future, is a responsibility shared with every U S aircraft manufacturer by The Ohio Seamless Tube Company.

THE OHIO SEAMLESS TUBE COMPANY

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Plant and Main Office
SHELBY, OHIO

MANUFACTURERS OF SEAMLESS AND ELECTRIC-WELD STEEL TUBING

FLEXIMOLD

More Efficient—More Durable

Ignition Shielding

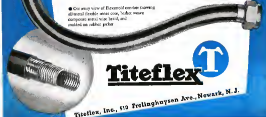
Fleximold is a new ignition shielding conduit specifically developed by Titeflex to provide the most efficient shielding qualities—while increasing conduit durability and fatigue resistance.

Superior radio shielding is achieved by combining the Titeflex flexible inner core with a specially developed composite metallic outer braid.

Maintenance costs are lowered... conduit life is increased—by means of a molded-on protective jacket of synthetic rubber.

Further information on "Fleximold" and other Titeflex aircraft shielding products will be furnished on written request. Titeflex engineers are available to help solve specific problems.

● Cut away view of Fleximold conduit showing all-metal flexible inner core, basket weave composite metal wire braid, and molded on rubber jacket



Titeflex

Titeflex, Inc., 510 Frelinghuysen Ave., Newark, N. J.

PAN AMERICAN WORLD AIRWAYS SYSTEM

Use Them . . . .

PHOTOS: Courtesy PAN AMERICAN SYSTEM—Latin American Division Base, Miami

SIOUX AIRCRAFT WET VALVE SEAT

GRINDING MACHINES for INLINE and RADIAL MOTORS

WRITE FOR DETAILS

STANDARD THE WORLD OVER

ALBERTSON & CO., INC. SIOUX CITY, IOWA, U. S. A.

ONLY ONE WAY TO *Correctly Tension* A STUD OR BOLT

Snap-on TORQOMETERS

insure accuracy — tell tension as bolt is tightened . . .

WHERE specifications call for accurate, *uniform* stud or bolt tension, Torqometers should *always be used* "Guesswork" tightening is an open invitation to all the troubles that follow mechanical distortion . . . wasted power, dangerous wear, breakage of parts. Even highly skilled mechanics cannot be expected to approximate specified pressures.

With Snap-on Torqometers any worker can tighten bolts to the exact foot-pound of tension *every time*... and on delicate mechanisms, to the *exact inch pound.*

He *sees* the applied torque as the bolt is tightened . . . as easily as reading a watch

Everywhere in aviation Snap-on Torqometers are being adopted as standard wrench equipment for precision assembly and maintenance operations. Available in a complete range of sizes from zero to 30 in. lbs., up to 2,000 ft. lbs Send for Snap-on catalog of power and hand wrenches for production and maintenance.

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Involute Gages

An Involute Spline Gage—dwarfed by a match but accurate to a "Tenth"

Whether it is tiny or takes a couple of husky hands to manipulate, an involute spline gage by VINCO is the ultimate in accuracy and finish.

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Exclusive techniques and methods, developed through twenty years of intensive application to this gage production problem, have given us this leadership. Use this specialized experience to assure the reliable inspection control of your involute splined production parts.

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Even K & E has never devised an instrument that would make it unnecessary to think. But we have spent 78 years designing and producing things that make it easier to act after thinking ... drafting instruments and related materials that give the engineering hand and eye almost the same precision as the engineering brain. How well K & E products serve as partners in creating is shown by the reliance placed in them by engineers and draftsmen throughout the world.

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*Trade Mark   *WYTEFACE Steel Tapes and Tape Rules are protected by U. S. Pat. 2,089,209*

FOR AIRCRAFT ENGINES...AIRCRAFT SPARK PLUGS

Western Air Lines averages 200,000 MILES on each BG Spark Plug

Western Air Lines, Inc.

GENERAL TRAFFIC OFFICES: 510 WEST 6TH STREET, LOS ANGELES 14, CALIF.

July 1, 1946

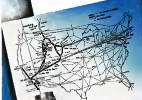
The BG Corporation
136 West 52nd Street
New York 19, New York

Gentlemen:

Western Air Lines has equipped a portion of its fleet with BG RB-19R ceramic-type plugs. These units are removed every 125 flying hours for visual inspection. No adjustments have been found necessary to these plugs until they have been used in excess of 400 hours. We find that the average life of this type spark plug is about 1000 hours (200,000 miles) which is convincing proof of both quality and performance.

Very truly yours,
Wm. Maxfield
William Maxfield
Superintendent of Maintenance

William Maxfield, Superintendent of Maintenance (*center*) and C. N. James, Vice President in Charge of Operations (*right*), Western Air Lines, inspect a BG spark plug.



First American air line to complete 20 years service, Western finds in BG ceramic-insulated plugs long, efficient life and economical, trouble-free service.

The superior qualities built into BG plugs have made them standard equipment on major air lines for over twenty-five years.

THE BG CORPORATION
136 West 52nd St., New York 19, N. Y.
MANUFACTURERS OF BOTH CERAMIC-INSULATED AND MICA-INSULATED AVIATION SPARK PLUGS

Precise VIBRATION MEASUREMENTS

G-E AIRCRAFT GENERATOR
Types and Ratings

DIRECT CURRENT

Type P-2 is rated 200 amp at 30 volts, 4400/8000 rpm or 3000/8000 rpm. Type R-1, 300 amp at 30 volts, 4500/8000 rpm or 3000/8000 rpm. Type Q-1, 400 amp at 30 volts, 4100/8000 amp. All have a ventilating air-pressure value of 6 in. H_2O.

A-C CONSTANT FREQUENCY

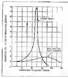
400-cycle, constant-frequency alternating-current generators are rated 40 kva, 208/120 volts, 6000 rpm, and 20 kva, 208/120 volts, 8000 rpm.

A-C VARIABLE FREQUENCY

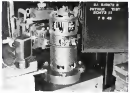
Variable-frequency a-c generators are rated 200 amp. 30 volts, d-c (10 amp, 120 volts a-c) 4400/8000 rpm, and 10 kva, 208/120 volts (400–800 cycle a-c) 4000/8000 rpm.

GAS-TURBINE STARTER GENERATORS

Built to deliver 400 amps at 30 volts d-c, 3700/7200 rpm. As a starter, the unit develops 330 inch-pounds torque at 1500 rpm, 340 amps, 20 volts.

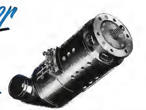


Steady-state response of quill-shaft assembly with and without friction-plate damper



Apparatus for vibration test on generator frames.

...SHOWED US HOW TO BUILD *Stronger* AIRCRAFT GENERATORS



Early in the war, Army airmen asked us to design a high-output, light-weight electric generator for their heavy bombers. At that time, vibration and its effects on engine accessories was still a mysterious "bug."

Its major causes were periodic forces and torque due to the combustion cycle, unbalanced inertia, and aerodynamic reactions. Very little information was available on the vibration characteristics of accessories on aircraft engines, and design was primarily based on past experience.

There was no doubt about what vibration could do to a generator. Either the mounting flange or end frame cracked, mounting screws broke, or the armature drive shaft and coupling failed. Excessive brush deterioration also occurred.

VIBRATION DATA NEEDED!

Our first job was to determine the characteristics of vibration of generator installations and to obtain data which would provide correlation between flight and laboratory tests and design. Exhaustive flight tests and measurements were made on the Army and Navy "heavies"—the B-17 and the B-24, the B-29 and the PB4Y2. On the basis of flight and laboratory tests new designs were made. Additional flight measurements and flight endurance tests were made on new designs to determine their safety factors.

THE NEW FLANGE

Guided by the data which these tests produced, G-E design engineers developed a generator housing with an adequate safety factor. Yet it was remarkably lightweight. This flange absorbed tremendous punishment from vibration with no ill effects. This was proved during its flight-performance tests when no failures were reported after months of flight testing. Made of forged steel, its specially designed contours prevent the concentration of destructive vibration stresses.

NEW DAMPER BARS VIBRATION!

The quill-shaft and friction-plate damper assembly found on G-E aircraft generators is also a result of G-E vibration studies. This assembly, by absorbing engine torsional vibration, has practically eliminated drive-shaft failures. The function of the damper is shown in the curves on the opposite page.

At the war's end thousands of military transport and combat aircraft had been equipped with vibration-proof G-E aircraft generators.

THE VALUE OF G-E RESEARCH TO YOU!

Whether you are concerned with generators, voltage regulators, relays, or complete power systems, you, too, can profit by G.E.'s basic research in the aviation field. It is your assurance of full-rated performance of aircraft electrical equipment. You are cordially invited to discuss your electrical problems with a G-E application engineer. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

Precision AIRCRAFT GENERATORS

GENERAL ELECTRIC

a name identified with good MOTOR performance

Lamb Electric

Specially designed for each particular application and with quality and dependability built into every part, Lamb Electric Motors have established a reputation for long, trouble-free performance.

Contributing importantly to this good performance is our experience gained in 31 years of designing and building small motors for over three thousand special applications. These applications, embracing almost every type of small motor driven product, include: home appliances, production machines, industrial tools, business machines, and many other classifications.

THE LAMB ELECTRIC COMPANY
KENT, OHIO

Light weight universal motor specially designed for portable devi

This universal mot sed for such applicati com mercial vacuum ners, brake drum lathe el balancers, pipe ers, air compressors,

Rugged construction is a major factor in the reliability of this motor widely used in the field of mechanized equipment.

Base-mounted, explosion-proof aircraft geared fuel transfer pump motor.

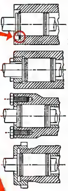
Lamb Electric
FORMERLY Black & Decker Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

New Ball Bushing is prefabricated for fastening with Waldes Truarc Retaining Rings

WHICH OF THESE FOUR WAYS WOULD YOU USE TO HOLD BALL BUSHINGS?

Having launched a revolutionary new product, Thomson Industries, Inc., Long Island City, promotes customer satisfaction by also determining the most efficient method of installing the Ball Bushing. With all possible methods of fastening at its disposal, Thomson Industries recommends Waldes Truarc Rings—and proves its conviction by pregrooving the Bushing. Why? The reasons are obvious on this page.



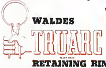
1 Compare the compact simplicity of this Truarc application with the designs below, any of which are standard good practice. *See how Truarc cuts costs of material, machining and assembly.*

2 You could use a collar like this, with its extra material, tapping, threading and additional assembly time.

3 You could fasten it with bolts—look at the extra material and machining in the housing; see how it complicates assembly.

4 You could retain it with a heavy external collar—extra material and labor, more time on the assembly line.

Whether your product is still on the board or has been in use for years, there's a Waldes Truarc Retaining Ring that will make it simpler, more economical to make and repair. Truarc Rings conform to NAS standards, give a never-failing grip. Truarc's constant circularity is assured by its patented tapered design. Truarc engineers can guide you, help you, make suggestions. We'll give your particular problem individual attention without obligation.



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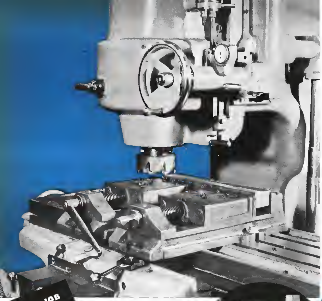

Here are the facts of this job taken from the operation and performance sheets. The machining time per piece with the old method was 15.7 minutes. Compare this with the performance shown below:

OPERATION:	Face mill four sides
WORKPIECE:	Slotting attachment ram
MATERIAL:	S. A. E. 4615 forging 2¼" x 2¾" x 18½"
MACHINE:	50 CSM Vertical
CUTTER	6" dia., 8 Tooth CSM Carbide Face Mill with 7° negative primary rake angle — .020" wide
CUTTER SPEED:	275 rpm
TABLE FEED	25 ipm
DEPTH OF CUT	¼"

MACHINING TIME: 3.8 minutes

Total saving in actual machining time 11.9 minutes or 75.8%

The part machined in this job is the operating ram used in a slotting attachment for Kearney & Trecker Milling Machines. It must be tough and accurate. It is milled to a semi-finish state on the CSM and finish ground to final accuracy.

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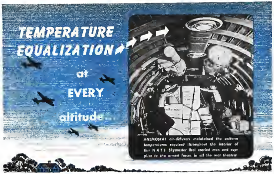

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BIKINI LESSON

When General Galliéni commandeered the Paris taxicabs for military service in the first Battle of the Marne, the mechanization of World War II was foretold When German V-2s harassed Britain and atom bombs tipped the scales against Japan, the pattern was set for a future war which we hope most ardently we can prevent or delay.

Our ability to prevent or delay it will depend upon how well we learn the lesson that future wars begin technologically where previous wars left off. And so our preliminary evaluation of Operation Crossroads, prior to the Baker Day tests, indicates the need for major revision of our long range air force thinking in terms of the atomic age.

Although it is too early to discard our current types of military aircraft and engines, it is not too soon to plan and build the air weapons of the next decade. We must provide for immediate emergencies and at the same time vigorously pursue the portents of Bikini in shaping the air force of the future.

The apocalyptic cloud revealed no atomic antidote. Maj. Gen. LeMay's conception of defense against atomic attack boils down to the cold fact that the nation which succeeds in first striking the vital manufacturing centers of its adversary is most likely to win. This means that defense has practically disappeared and that we must concentrate our efforts on offensive strategy.

This new concept demands intelligence sufficiently perfected so that we know exactly when to strike before we ourselves are stricken. It also requires instant knowledge of weather conditions on a world-wide basis. We must revise our strategy and tactics so that we can think and act in minutes instead of years.

Highly accelerated warfare also demands an infinitely higher degree of perfection in design, installation, and maintenance of the components of aerial weapons as well as of the weapons themselves. Failures can bring swift and costly retribution when guided missiles carry atomic warheads. We simply cannot afford the risk of an enemy capturing these new and terrible weapons intact to turn them back against us.

In the lesson of Bikini (elaborated on pages 38-41 by Aviation's Crossroads correspondents) there is a mandate for the members of every branch of aviation, and for the Congress. The strategists and tacticians must revise their thinking in terms of the utilization of air weapons.

We will still need big bombers of ever-increasing range, flying with and without pilots. Small fighters will still be required, but they will grow larger in size and range and some of them may ultimately divest themselves of their pilots. Guided missiles have proved their indispensibility and a remarkable degree of perfection. They will lead inhabited types of aircraft into the supersonic speed range. Piston and turbine power plants must be developed, hand in hand, to find the niche where each one fits.

A favorable environment for research, development, and pilot production of all of these aircraft must be created by sound laws and methods of procurement which make it worthwhile for private industry to do its traditional part of this job. The wherewithal must be furnished to enable industry to maintain and exceed the high quality of all aviation and electronic products. Technicians and mechanics must be allowed to improve their skills to attain even higher perfection. These thoughts should remain uppermost in the minds of those who will shape and implement air power policy.

Although the fundamentals of air power remain fixed, the details of air force must be changed. The members of Congress who went to Bikini should bring back these thoughts to their colleagues and should be firm in their determination to create sound policy and wise implementation of America's air power.

Leslie E. Neville

EDITOR

Evaluating Operation Crossroads

By SCHOLER BANGS, *Aviation Correspondent attached to Kwajalein air base*

• From two on-the-spot editors come reasoned studies catalyzing the effects of the Bikini atom bomb test. In this one, Scholer Bangs clearly analyzes the revolutionary effects this new weapon will have on the whole aircraft industry, sharply defining the design, operation and maintenance trends which the A-bomb makes inevitable. In the second, Philip Swain, editor of McGraw-Hill's magazine *Power* and an atomic energy authority, gives in clear terms what nuclear fission means to future naval design and tactics.

Mr. Bangs operated from the air base at Kwajalein—flying over the target area within hours of the explosion and later going in by surface vessel to board target ship—and Mr. Swain was attached to the Navy press ship—*Appalachian*—also moving in quickly for a first hand survey—*The editors.*

Signposts of the future of American military aviation, many of them existing but previously unheeded, were erected liberally and made clearly visible at Operation Crossroads. The most significant indicate:

Complete obsolescence of the conventional airplane as a defense attack weapon within 10 yr.;

Interim replacement within 5 yr. of present bombing aircraft with very long range radio-controlled bombers and, later very long range manned bombers capable of delivering from a safe distance guided missiles fitted with atomic war heads;

Limited but continued production development of piston engines and jet bombers and fighters now on postwar assembly lines, with the size of orders gaged primarily to maintain a nucleus for instant expansion of aircraft production in a war emergency;

Increased emphasis on superior maintenance of bombers which will be called upon to strike at any place on the globe, and which will carry new high-precision controls and accessories vital, each of them, to successful performance of a given mission;

Immediate advancement of long range worldwide weather forecasting as an integral part of national aviation defenses;

Immediate re evaluation of U. S. air forces and drastic revision of now-obsolete concepts of air defense and attack to activate new tactics and weapons as they are developed.

These "signposts of Bikini" did not simply appear at the flash of the atomic wand which conjured up a 50,000-ft high "exclamation mark" against the hot blue tropic sky.

They were erected by the great and small of Army and Navy air arms and by the thousands of basic and applied research scientists and their aides called to the mid-Pacific to explode the world's fourth and fifth atomic bombs.

Of all who had their say on the experiment's impact on aviation, Maj Gen. Curtis LeMay, Assistant Chief of Air Staff for Research & Development, was perhaps most significant when he said, "We are in the process of changing the whole philosophy of our air forces."

How soon this new order will mature Gen. LeMay, a practical man now fully conscious of the multitude of delaying influences which can be imposed upon new factors, would not say.

The degree to which Congress senses urgency in future air planning and provides funds adequate for air research will influence the time table. Also, resolution of the joint air forces issue, and the decision of who will be Mr. Big in guiding the drastic switch from fighting yesterday's war into acting for tomorrow's defense must be considered when thinking in terms of time.

Col. H. T. Alness, head of Army's Boeing B-17 drone unit at Eniwetok, who leaves his Crossroads assignment to head up the Army's portentous 1st Guided Missiles Group, believes that as much as 10 yr. of research lies ahead in perfecting the tactical use of guided missiles, both air-borne to point of delivery, and ground-to-ground rockets. A heavy bomber man, he is convinced that the days of piloted-airplane bombing missions are gone. He talks of Boeing B-29s as "those antiques," yet feels that the transition from "antiques" to squadrons of drone missiles will be slow because of the research required to transform experimental rockets and jet or rocket-powered winged missiles into efficient long range weapons.

There is no contradiction in Alness' assuming that perfection of guided missile tactics may require 10 yr. and, in the same breath, saying that the manned bombing mission is a thing of the past—manned, that is, insofar as strike planes carry flight crews, gonners and bombardiers.

Should the United States be involved in warfare next year there is a strong probability that pilots of bomber squadrons could sit 50 to 100 mi. from the target, watching their unmanned bomber flights plunging through antiaircraft and fighter interceptors and grateful for the demonstration at Bikini on July 1, 1946.

Bikini established generally that both heavy bombers and fighters can be precision-flown through heavy turbulence by remote control as accurately as if operated by crews aboard the planes. Moreover, drone bomber squadrons should go into a strike with an appreciable gain in either range or bomb load. They would be stripped of the weight of men, crew gear, and personnel armor weighing several thousand pounds per plane. Even the most complex installation of radio control could easily weigh less than 1,000 lb. per airplane. The full installation of impulse receivers, control actuating motors, radar, and television in the B-17 drones flown through the center of the Bikini atomic blast cloud weigh no more than 500 lb. per plane.

It is difficult to attach importance to the drone operation of Navy's Grumman F6F fighters as such. True, they gave practical demonstration that a piston engine drone fighter can be flown with a high degree of accuracy by a very busy pilot in a "mother" fighter, but the conventional combat utility of such an arrangement is not apparent. Rather, it might be said the fighter drones point to ultimate use of very high speed winged missiles, jet or rocket propelled and aimed by a distant control pilot flying a comparably fast aircraft.

Col. Alness anticipates for the radio-controlled winged missile of the future a speed range reaching up to 2,000-3,000 mph. Of this trend in air warfare, he was emphatic in saying: "There is no question of its coming, it is here."

With the expressed attitudes of Gen. LeMay and Col. Alness in mind, and the assumption that any new war will open with an atomic bomb attack, Gen. LeMay's reasoning on immediate defense planning gives support to this article's opening estimate of aircraft needed now to rebuild our national defense.

Gen. LeMay envisions three possible defenses against atomic bomb attack. They may be listed in brief, for reference, as:

1. A strong anti-aircraft and fighter defense using atomic counter weapons to intercept and destroy atomic bombers or missiles before they reach their targets;

2. Striking at atomic bomb bases;

3. Striking at atomic bomb manufacturing centers.

Should the first defensive measure be developed to an efficiency that would destroy 80% of invading atomic bomb carriers, enough would get through to do crippling damage in a very short time during repeated strikes. Japan's inability to knock out American bomber bases in the Marianas convinces Gen. LeMay that the second measure could not be expected to be very effective.

Only the third, he feels, has a chance of success. Executed instantly, it would have the effect of halting the flow of atomic bombs to bomber or rocket bases, and the attack would terminate with starvation.

Obviously, the effectiveness of such a defense would depend upon an initial limitation of atomic bomb "stockpiling" by an aggressor nation; and it is quite likely that any nation contemplating a surprise attack would not risk disclosure of the fact by appreciable advance movement of atomic bomb materials from factories to launching sites.

Gen. LeMay indicated that the Air Forces and Manhattan District are at work separately on methods of policing production of fissionable materials outside the United States.

Whether early detection of atomic bomb production depends on cloak-and-dagger methods or is possible by the use of sensitive instruments was not disclosed. However, granting that it is possible, it qualifies the value of the third defense measure and indicates the type of aircraft which probably will be dominant in military production orders through the interim period of guided missile research:

Fast, heavy bombers capable of striking any point on the globe and returning, possessing flight characteristics suited to radio remote control operation.

It might be pointed out here that until the performance of the very long range Northrop XB-35 flying wing bomber (see article by John K. Northrop on page 61) and the Consolidated Vultee XB-36 bomber are proved, our nearest approach to those general specifications is the Boeing B-29 and its advanced version, B-50.

If Gen. LeMay's views reflect our defense planning at the highest level, witnessing Bikini results by House and Senate leaders may very well lead to an early upward trend of appropriations for interim aircraft and pilot production of guided missiles. The General predicted: "The time will come, I hope, when the bulk of our fighting will be done automatically. I'm among those who don't like to get shot at," adding that "we must realize that if another war comes we will be the first attacked. The security of the space of our surrounding oceans is gone, and with it has gone time to prepare war resources in defense against an aggressor."

Foreseeing radical developments in air weapons, he conceded the usefulness of the military airplane will be measured, in time, by the money spent now on new weapons research. "I only hope that when the time comes we can let go of the airplane, the heavy bomber, quicker than the Navy has let go of the battleship," he said.

There were some present during the Bikini tests who believed Gen. LeMay's and Col. Alness' time estimates for tactical perfection of guided missiles to be too conservative—that such weapons may be expected to be extremely useful within a very short time. If this is true, it may be said the Bikini tests hastened guided missile evolution to a marked degree.

It may be expected that drone radio receiving devices and their mechanical slaves used on the B-17s will have set the pattern for drone bomber installations. Similarly, the counterpart equipment used in the Navy F6F should indicate electronic and mechanical hookups for a variety of winged missiles of comparable size.

Too, performance of the drones at Bikini provided a rigorous test of control methods under near-combat conditions and—a now important consideration—while functioning in the midst of intense radioactivity within the column of the atomic bomb's blast cloud.

This atomic proving ground established that drone bombers (or guided missiles) will suffer no radiological interference with their control.

There was no noted evidence of interruption of the electronic control of the drones.

Electric circuits throughout the airplanes functioned normally while flying through the cloud.

Engine power remained constant with no evidence of oxygen starvation.

Turbulence at all levels within the cloud column probably was less than that encountered within continental thunderheads. This was borne out by the fact that drones leaving the cloud showed altitude changes of less than 500 ft., maintained stability within the 30-deg. limitation for recovery by the autopilot, and suffered no evident structural damage.

Mass of wreckage that once was superstructure of submarine 'Skate' following 'Able Day' atomic bomb test at Bikini (Press Assn photo)

All Army bomber drones were recovered and brought to perfect landings at Eniwetok, and the Navy F6F drones from the carrier Shangri-La were landed at Roi Island with one exception, which spun into the ocean 15 min. before the bomb was dropped. Loss of control possibly was due to failure of an electronic tube in the control circuit, and could even have been due to failure of an electric relay contact through corrosion, which has made all types of maintenance difficult in the tropic climate of Operation Crossroads.

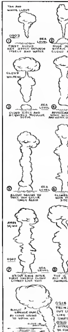
Agreeably surprised at the success of both Army and Navy drone results was Col. R. E. Jarnoe, chief of the technical evaluation section of Crossroads' Task Group 1.5 and chief of the armament laboratory at Wright Field prior to his current assignment. Of the B-17 drone which entered the blast cloud at 24,000 ft during the peak of turbulence he said, "We figured the chances were 90-to-10 that we would lose this one."

Commenting on the Navy's drone loss, he pointed out that failure of a single radio tube in a group of circuits using 150 tubes per plane would be critical and easily cause loss of the aircraft. While this seems to indicate that flights of drone aircraft on a combat mission might be strikingly vulnerable to anti-aircraft fire and fighter interception, there is little doubt that combat installations of electronic equipment would be both heavily armored and thoroughly cushioned against explosion shock.

Considering that Col. Alness received orders to set up the bomber drone operation only in January, and that it was not until March 15 that his group received delivery of ten stock-shelf B-17Gs, the success of instrumenting them for a perfect operating score on July 1 shows what should be accomplished in outfitting large forces of bombers for drone combat assignment.

Time for preparing the drones for the first Bikini test was so short, in fact, that final perfection of radio control devices was not accomplished until after the planes had been flown to Eniwetok. There a technician of the group, Lt. Peter R. Murray, invented, built on the scene, and installed a radio-controlled differential braking system to replace the simple "full on" radio brake control used until then. The differential braking was final insurance against loss of returning drones by ground looping on the landing runway.

While maintenance of the 68 Army-Navy aircraft which flew in the Bikini tests was unusual only in the intensity with which ground crews applied themselves to the job of having their planes ready on the flight line, the trend toward very long range bombing with tactically



Sketches made in flight by Lt Col E. G. Morrison, Joint Task Force One as he flew around Bikini target area in B-29 photo plane. They convinced Manhattan District analysts a high order of fission had been obtained.

high-value loads of atomic bombs undoubtedly will induce a critical review of present maintenance procedures.

Loss of a single plane over enemy territory through a maintenance "abort" might prove disastrous in giving an enemy a ready-assembled atomic bomb which could be re-delivered to its point of origin with telling effect.

Lt Col U S Nero, in charge of maintenance for Task Group 1.5 planes used at Kwajalein, believes the trend toward very long range bombing with massive aircraft may call for adoption of specialized maintenance procedures used experimentally in preparing the 58 B-29s and C-54s under his jurisdiction for the Bikini operation. He feels that efficient maintenance of large aircraft is best gained by assigning mechanics to specialized jobs rather than having an overhaul crew work "around the clock" on a given airplane.

Presumably very long range bombing would call for operation either from continental points or from outpost bases which would be sufficiently developed to allow maximum use of maintenance techniques indicated for large planes. Accordingly, utilization of heavy bombing equipment should hold to a high level in comparison with that resulting from the often inadequate maintenance of planes flown from forward bombing bases during the closing phase of the last war.

Weather forecasting will be of mounting importance as long range bombardment planning develops.

Coordination of world weather data extending far beyond information now obtainable, and a coverage of Pacific, and Arctic weather "blind spots" will be necessary.

Reasonably accurate 15-day forecasting is now the not unreasonable hope of meteorologists.

Accurate 24-hr. forecasts—and by that extreme accuracy is implied—will be on the "must" list of tactical requirements.

Planning for a 5,000-mi bombing mission would have to go beyond consideration of winds, icing and turbulence.

Weather preparations for Operation Crossroads have disclosed the probability that long range missions for very heavy bombers will have to take into consideration relative humidity forecasts as a critical factor in planning engine power settings and obtaining maximum performance from minimum fuel loads.

Tip-off to this new use of weather forecasting was given in daily weather flights conducted jointly by the Army and Navy to augment spotty weather data provided by limited shore and ship observations, radiosonde, and rawin—the latter radar-tracked high altitude balloons.

Planes sent aloft daily to cover the

north and east Marshall Islands area, and south to points below the Equator, carried as standard equipment the psychrometer, which permits the airborne meteorologist to obtain wet and dry bulb temperatures and relative humidity at any time.

Experimentally, psychrometer readings have been applied to evaluation of power performance of weather plane engines at varying degrees of humidity, and with such success that weather officers at Kwajalein believe use of a psychrometer aboard a massive airplane—such as the XB-35, XB 36 and Constitution—will pay impressive dividends in fuel economy. With a psychrometer, the flight engineer will be able to have a positive check at all times on the output of his power plants, and will vary power settings in flight for humidity as well as for altitude, speed, and decreasing fuel load factors.

Drone bombers, if accompanied at reasonable distance by mother planes, will be given the advantage of humidity power control by radio.

While all this discussion has had a strongly militaristic flavor, it must be borne in mind that Operation Crossroads essentially has been little other than a military show.

However, aircraft and accessory manufacturers, research engineers, and airline operators, too, should find the military trends brought into focus at Bikini of strong commercial significance.

Military development of heavy drone aircraft will lead to civil application of remote control techniques conceivably useful in the operation of crewless air freighters having their entire lift devoted to fuel and payload.

Similarly, as the early development of domestic civil airways and weather facilities provided tailor-made channels for movement of military aircraft in wartime, future long range bombing defense preparations will justify world air route and weather reporting expenditures which will be of immediate benefit to U. S. commercial air carriers.

Important as the Bikini atom bomb tests have been in accenting the probable future of military aviation, it was disappointing yet understandable that the operation was restricted to the use of a limited variety of obsolescent aircraft.

The only planes active in the target area were B-29s, C-54s, B-17s, F6Fs, TBMs and B-17 and PBM rescue craft.

Now "ancient" and designed for other purposes, these planes were modified brutally and fantastically to carry millions of dollars worth of the very latest in scientific measuring devices, droppable blast gages, and cameras.

Amron Katz, civilian photographic physicist attached to Wright Field, would like to have seen the Lockheed P-80 jet fighter used to flash in and out of the area at high speed and able to hunt for momentary photographic positions which could not be reached by camera planes having half the speed. He believed, too, that the P-80 would have given a nearly-vibrationless platform for heavily-filtered cameras operating at low shutter speeds.

Beyond these aspects, the use of drone jet fighters in the atomic cloud would have provided, it seems, valuable information on performance of turbine engines in flight through radioactive debris. Also, valuable information would have been gained concerning the accuracy of control of lightweight, high speed jet aircraft in flight through combat sky rubble.

The only plausible explanation for neglect of the use of the P 80 and other modern aircraft over Bikini was that it would have compounded maintenance problems already serious with the few types of aircraft actually used.

Considering the total effort and cost involved in Operation Crossroads this appears to be, in retrospect, an admission of failure to take full advantage of aviation research possibilities offered by the atom bomb tests.

A-Bomb vs. Surface Ships

By **PHILIP SWAIN,** *Editor, "Power" and McGraw-Hill Correspondent at Operation Crossroads*

DESPITE MANY FOREWARNINGS that the Bikini "Able Day" test was a laboratory setup and not a simulated attack against a fleet not usually arranged in a harbor, newsmen were tempted (and some yielded) to play up a strictly technical operation as a sort of glorified bowling match with the navy ships as the pins.

By itself, of course, the number of ships sunk or damaged means nothing, for results can be varied by spreading the ships or bringing them closer together. Despite much gossip to the contrary, I think it obvious that the first test was reasonably well designed to carry out the Presidential directive that graded damage, from great to slight, should be obtained.

The true aim of these tests was to secure a set of data in curves—rather than a box score—curves correlating pressure, temperature and damage to every ship, every part, every piece of equipment, with the distance from the bomb.

It may be hard to make the American public understand how vital is such information. But without it naval designers cannot build ships or bases suited to an atomic age.

To questions regarding the value of this test my answer is that Operation Crossroads will cost less than one new battleship, but will give data essential for the design of new ships and bases and the determination of tactics. Although a city would generally be a better target, we should not assume that an enemy having plenty of million-dollar atomic bombs will not drop one on a hundred million-dollar ship.

Independent scientists on our sister ship, the *Panamint,* tell me they expect valuable information in the field of pure science, particularly in radiation from high temperature sources, in oceanography and radioactivity, biology and botany. While the big bosses of Operation Crossroads justify their experiment strictly as a source of essential military information, general scientific data will be an important byproduct, and the public interest is well represented at Crossroads by the President's Evaluation Commission headed by Karl T. Compton, President of MIT, as well as by the scientific observers on the *Panamint.*

I have seen no evidence that the test was "rigged" in any important respect to make an unfair showing for the Navy, but such charges and suspicions will inevitably arise. The public will have special need for the advice of competent and disinterested observers. Even with such advice there is danger that Crossroads may become one of the most persistently misinterpreted technical experiments in history.

The "Able Day" experiment was well planned and executed. The bomb was of normal efficiency and performed as informed opinion had predicted. Those who expected the impossible—trees uprooted at Bikini Island three mi. away or steel melted on ships a quarter-mi. away—were disappointed.

Such unscientific expectations arose largely from failure to understand how rapidly all bomb effects must fade with distance. The much advertised "100,000,000-deg heat" was confined to the bomb's center and lasted perhaps a mil-

(*Turn to page* 145)

Here's What the Public Wants

Nation-wide survey reveals what average men and women has been led to expect in personal planes; shows urgent need for widespread education by entire industry in national air power policy and airline facilities.

If manufacturers of military, transport and personal planes, and airline operators are to materially enlarge their markets, a well planned, long-range educational program for John Q. Public is still necessary.

Too many average Americans know too little about the fundamentals of airpower, too many know too little about what they can actually expect in personal planes, and too many are just plain afraid to fly, whether it be in an airliner or a personal plane.

Such are the inevitable conclusions reached from a study of a nation-wide survey of three major phases of the aircraft industry made for the *Saturday Evening Post* by the Research Dept. of the Curtis Publishing Co.

Strangely enough it is in the field of national policy that the average man and woman seemingly has the best grasp of the situation, but when fundamental reasons are reached in the questioning it is evident that there is a tremendous field for spreading knowledge.

To the question "In the future do you think the natural barriers of water and distance will be adequate protection for the United States against enemy attack?" 88% said no and, unlike the situation holding after the last war, 3% more rural people gave that answer than did those in cities. To the question "Do you believe we should maintain a military force during peacetime as an aid to insuring peace?" over 95% replied yes.

And 78.5% said they would be willing to pay more taxes than they did before the war to support a powerful Army, Navy and Air Force. Here too, the answers were quite evenly divided among urban and rural areas—79.1 and 77.1%—and among men and women—80 and 77.1% respectively.

Still encouraging were the answers on how airpower should be maintained: 76.3% said the Air Force was the most important of the three services, 21.8 said the Navy, 1.6 said the Army, and 7.1 said all three. To the question "Do you think that our government should spend money keeping up to date on aircraft research, invention and development after the war?" 95.7% answered in the affirmative. And of the total, 49% said some government department should be responsible for doing this. 31% thought the aircraft industry should be responsible and 18.5% said the military.

This opinion was bulwarked by answers to another question: "Do you think aircraft manufacturers should provide their own funds for research, experiment and invention for military aircraft, or should they be financially assisted by the government?" To this 69.2% thought the government should give financial assistance; 29% said the industry should do its own research financing.

Here, however, the need for education begins to show up. While 88.5% said yes when asked "Recognizing the fact that air is everywhere, over both land and water, do you think the United States should strive to be the leading airfaring nation?" almost everyone gave a superficial answer.

Only half of one percent said "it will support the aircraft manufacturing industry and keep us prepared in peace time", only 0.2% said "it would provide the personnel that if needed could quickly be converted to military use." Over 36% gave military reasons, over 35% agreed "we should naturally always strive to be the leader in the development of aviation", more than 11% said we have the location and facilities for accomplishing it and 10.5% said it would help develop future foreign trade.

Since, as the survey so conservatively decided "less than 1% seem to understand that airpower derives from a successful and always prepared aircraft industry, it would seem highly desirable that the other 99% be educated to a full realization of this basic fact. To insure our freedom and security against enemy action in the future, a well directed program of education to this end may not only be desirable but actually imperative."

Almost as big an educational job appears necessary in the personal plane field—or revolutionary planes must be created—because John Q. Public wants a tremendous amount for his money.

First, however, a great many more people must be educated to want personal airplanes, for only 32 out of every 100 men and women even wanted to own their own plane, and of non-owners only 7 of every 100 was "definitely planning" to buy one.

Here are the reasons and percentages why nearly 68 out of every 100 said they were not buying: too expensive, 30.7%; no need or use, 20.1; no desire or interest, 17.9; too old and poor health, 14.2; fear, 10.1; miscellaneous reasons, 9.6; prefer other means of transportation, 8.7; and, not convenient to own a plane, 8.1.

And here is how the average man feels about the question: "What features do you consider essential or necessary in the plane you buy?"

No. of seats—including pilot	
4 seats	41.8%
2 seats	21.5
3 seats	15.7
5 seats	11.3
Cruising speed	
80–100 mph	25.4%
101–120 mph	7.7
121–150 mph	38.1
151–180 mph	3.7
Over 180 mph	18.3
Cruising range	
300–350 mi	26.1%
351–500 mi	39.5
501–750 mi	9.2
750–1,000 mi.	5.0
Over 1,000 mi.	9.0

But that isn't all the public wants. When asked, "What other features?" the important percentages included these: radio, 30%; safety devices, including automatic pilot, 28; heater or air conditioning, 8.5; all modern equipment, 8.5; sturdy construction and good motor, 5.3. Others, all under 5%, wanted low landing speed, navigation instruments, comfortable seats, retractable gear, short landing and takeoff runs, flaps, and easy-to-handle planes.

And what would the public be willing to pay for a plane embodying the majority of these features? Nearly 30% would pay between $2,000 and $3,000; nearly 22% from $1,500 to $2,000, over 15% from $1,000 to $1,500, 11.6% from $3,000 to $5,000; and only 4.6% from $5,000 to $10,000. Nearly 11% didn't know what they'd be willing to pay; only 2% would go over $10,000 and 4% wouldn't pay more than $1,000.

Such answers can only mean a challenge to the entire personal plane industry. As the survey reports, "education is the one solution for meeting this situation. People need to be told and re-told the prices of the planes and also the costs of operation in relation to features provided and specific performance. ... Permanent and growing markets need satisfied customers. For customers to be satisfied, they need to be well informed."

While it is agreed the airlines have made almost unbelievable strides, the potential market has barely been scratched, again showing the need for continuous public education in this fast growing field.

The volume of this market, was indicated by two questions, first "Have you ever taken a ride in an airplane?" (to which 40.6% said yes) and second, to those who replied yes, "Was it an airline plane?" to which 35%, or 14.2 of the total gave an affirmative answer.

The reasons why some 60 of every 100 men and women had not taken an airplane ride were varied, but several of them can be interpreted as resulting from fear. Nearly 44% frankly admitted to being afraid, while 49% said they had had no occasion or were not interested; 12% said they preferred other ways of traveling, a little over 1% said they didn't like height or were too old and nearly 2% gave miscellaneous reasons. Only 4.7% said air travel was too expensive.

Narrowing the field specifically to airlines the survey showed that 45.8% planned postwar travel by air, 43.7% were not going to use the airlines, and 10.5% didn't know. Of those who were not planning to use the airlines 37.5% said they had no occasion or desire, 36.9 said they were afraid or too old, 17 preferred other forms of transportation; 8.6 said it was too expensive, and 2 objected to height.

There are other educational factors besides fear, however, for "while the survey clearly indicates the favorable attitude of the public toward airlines and airline planes, many people who have traveled by airplane appear to need additional education for a more comprehensive utilization of the facilities provided. Airlines like any other agency of transportation, need an even flow of passenger traffic during all seasons of the year. Only 32½%, however, of those who have traveled by airlines have done so during all seasons of the year. Two-thirds of airline travelers have used airlines most in the summer and least in the winter. Also, when asked whether they prefer to travel by airlines during the day, the evening, or overnight, 59.4% reported they had no preference. Some 34.7% prefer the day for airline travel, 3.6% overnight, and 2.3% the evening. That cost does not appear to be a serious deterrent in the use of airlines is again indicated when 62.6% of airline users said they would prefer to retire and sleep in a berth for an additional charge. Twenty percent said they had no preference and 17.4% prefer to sit up in a seat. A program of education on airline facilities and services would not only benefit the airline passenger, but also the airlines. An effort directed at leveling the peaks and valleys of airline travel during seasons of the year and hours of the day would appear to have ... desirable and worthwhile objective."

How The Survey Was Made

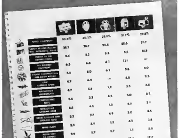
1. Planning—During 6 mo. of planning and building the schedule of questions prominent executives of companies actively engaged in aviation, and others in associations and organizations directly interested in the industry cooperated to provide invaluable assistance in devising the questions to be used. In addition they collaborated with suggestions on method and scope.

2. Opinions—Answers to all questions are opinions of men and women as individuals, not of a family member speaking for the entire family.

3. Personal interviews—Local interviewers were employed in each city, town and county or rural area surveyed. Each interview required on the average a minimum of 30 min.

4. The questions—No leading questions were asked; no answers were suggested. Extreme care was exercised to get a questionnaire that would give answers free of influence. The questionnaire went through 13 revisions and was pretested 400 times.

5. Scope—Opinions are based on complete interviews with 8,098 men and women equally divided and distributed throughout the U.S. in proportion to population in each of the nine customary census geographical sections, and within each section in proportion to population by urban and rural areas and by size of city and town. Interviewee age minimum was 18 yr. Minimum income levels were $1,500 annually in cities under 50,000, $2,000 in cities over 50,000. Distribution of interviews by income level was based on estimates used by Office of Civilian Requirements, latest authoritative source available, as follows: $7,500 per year and over 4.3%; $5,000-7,500 10%; $3,500-5,000 17.9%; $2,500-3,500 33%; and $1,500-2,500 32.9%. Interviewing was distributed as follows: 12 cities of 500,000 and over, 19 cities from 100,000 to 500,000, 13 cities from 50,000 to 100,000, 23 cities from 10,000 to 50,000, 16 cities from 2,500 to 10,000, 105 towns under 2,500, and 90 counties for farm interviews, the latter two making up the rural classification.



In addition to wanting four seats, 150-mph cruising speed and 500-mi range most people want or expect these equipment items on their personal planes—and their lack of aeronautical education is indicated by the fact they don't expect to pay much for planes with them all.

Network of Service Bases Started by Lockheed

First link of factory-directed overhaul and repair and parts supply centers under way in New York area as outgrowth of prewar and wartime experience in raising aircraft utilization.

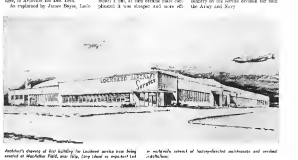
IMPLEMENTING its long term policy of providing the maximum factory-directed service facilities for both airline and individual owners, Lockheed Aircraft Corp. is establishing a major overhaul base at MacArthur Field, government-built base near the town of Islip, Long Island.

This new service facility represents a major step toward culmination of plans first described by Reagan C. Stunkel, Lockheed's general service manager, in AVIATION for Dec. 1944.

As explained by James Boyce, Lockheed eastern service manager, the philosophy behind this million-dollar venture is simply this: To give aircraft operators the most efficient and economical service possible so that they may increase utilization of their planes and thus render better and more economical transportation service.

The trend is somewhat similar to that in the automotive field—in the old days a man with a pair of pliers and a screwdriver could do a pretty fair job on his Model T but, as cars became more complicated it was cheaper and more efficient to have the work done by a service organization which had the backing of the manufacturer.

Establishment of the new base—which will be followed by others throughout the world—is a natural outgrowth of Lockheed's extensive wartime service experience, in which its service department employed more than 10,000 men in overseas operations alone. Among the largest, it will be recalled, were the operations in England, where the company operated major overhaul bases and modification centers for the Army Air Forces and British Ministry of Aircraft Production. These overseas bases—operated by Lockheed Aircraft Overseas Corp., a wholly-owned subsidiary—were in addition to the several modification and training centers operated in this country by the service division for both the Army and Navy.



Architect's drawing of first building for Lockheed service base being erected at MacArthur Field, near Islip, Long Island as important link in worldwide network of factory-directed maintenance and overhaul installations.

Establishment of the base in the New York area was a "natural", for all such operations must be at major terminal points, and it is almost certain New York will continue to be the terminus not only of practically all trans-Atlantic runs, but of many transcontinental routes as well. Setting up some of the foreign bases will, of course, have to be delayed pending clarification of terminus points on international routes. This factor may also mean moving some of the bases in the future. The base at Rineanna, Eire, for example, will go into operation within a month or so, but may eventually have to be moved to some point on the European continent.

Double Action at MacArthur

The MacArthur operation will be a dual base providing two functions: First, overhaul and repair and, second, supplying spare parts.

As aircraft have grown in size and complexity and, with recent additions of different types of aircraft, the airlines have found it constantly more costly to provide the equipment to service the craft and to train personnel for proper maintenance. By providing the essential equipment—especially costly testing units—which can serve many airlines, Lockheed feels it can render service more economically than the airlines can themselves.

In addition to eliminating the need for airlines' duplicating of expensive equipment, the MacArthur base will serve another important function, that of providing space, which is becoming an expensive capital expenditure item. This has become apparent at New York's Idlewild Airport, even before the lines have had a chance to begin operations there.

Architect's detail drawing showing modern construction of service base at which transports of all makes will be serviced. Carrying stock of spare parts and components is planned as important part of new type overhaul service.

In the initial stage of its operations, Lockheed's new base will concentrate on stocking spare parts for Constellations, but this base will be broadened as demand arises. No large stocks of instruments, propellers and similar items will have to be carried, however, since the base is strategically located within two hours delivery of practically all major producers of such units.

As was the case with wartime overseas operations, the Lockheed bases will not necessarily be confined to servicing Lockheed planes. During the war, it is pointed out, only 25% of the total work done at British bases was on the company's own craft. That other-than-Lockheed work may form an important part of the base's total volume is indicated by the fact that negotiations are under way to service foreign airlines whose repair and overhaul facilities were ruined due to bombing during the war.

While emphasis in the early stages of the game will be on airline service, the feederline, charter and individual owners are not being overlooked. These bases will in fact, be of special interest to operators of the Saturn, recently announced Lockheed feederliner. As president Robert Gross pointed out, "We do not expect many large orders—20 to 30 planes—for the Saturn, but we do look for many orders of two or three planes each." Having strategically-located factory service facilities, it is felt, will be of material assistance to such operators, for they will eliminate the need for large investments in repair and overhaul facilities that otherwise would be necessary.

Early Opening Slated

The MacArthur base is scheduled to start operations within the next 30 days and it is anticipated that all the original building schedule will be completed by next Dec. 1. The first building will be a 200 x 300-ft. combination office, shop and warehouse; other facilities to follow immediately will include a 200 x 300-ft. hangar of sufficient size to adequately house the Constellation.

That Lockheed believes it can succeed in this first of a network of factory-directed service bases is indicated by the fact that it has taken a 10-yr. lease with options to renew for another 10-yr. period.

First foreign link in Lockheed's service-base network was opened last month at Shannon Airport, Shannon, Eire in property having access to the Irish airport's three 6,000-ft. runways.

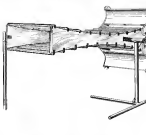
Reagan C. Stunkel, general manager of Lockheed Aircraft Service said the new base "will operate as a European distributing point for Constellation spare parts and components, as well as complementing the activities of our MacArthur Field service base on Long Island, and our home base at Burbank. This will greatly reduce costs of individual airline operation by providing consolidated service facilities at strategic points on the globe."

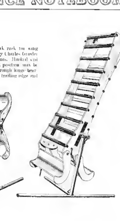
Henry H. Ogden, supervisor of Lockheed's wartime service bases in England will be in charge. He will be accompanied by general manager D. J. Stevenson, production supervisor E. M. Pritchett, key mechanics Maurice E. Rush and S. N. Farley, with the remainder of the staff to be recruited in Ireland.

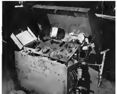
AVIATION'S MAINTENANCE NOTEBOOK

Wing Work Rack Has Novel Features

• Designed to hinge into two positions, for use either as a work rack for wing repair or for vertical storage of finished work, this device—built by Charles Gruder of Martin's Creek (Pa.) Airport—has saved its cost many times. Hooked end pieces, serving to hold wing leading edge when jack is in vertical position may be moved out of the way by disconnecting a small brace rod. Pin through hinge bearing of stand holds rack securely upright, and detachable leg on trailing edge end provides support when it is desired to have work horizontal.







Field Unit Tests Instruments Without Need for Their Removal

• To eliminate considerable time loss incurred during removal and replacement of instruments when making routine tests, this wheeled unit—developed by VTSC—is used by AOA at LaGuardia Field, N. Y.

Equipped with master testing devices and incorporating reels for pressure and vacuum hose and electric lead wires, this compact truck and its associated equipment permits checking of instrument without removing it from panel in cockpit. Inspection forms and instruction manuals are held in cover of equipment box (seen, left, in open position).

INTERCHANGEABLE TOOLS FOR DOUGLAS TRANSPORTS

Tool Number	Tool Designation
K65-6823GT	Hydraulic system bleeder coupling
S65-13940GT	Bungee spreader bar
K65-2710GT	Fuel tank wrench for parker fittings
K65-2708GT	Aligning motor mount wrench
S65-100570GT	Tailwheel spindle ball wrench
S65-2005811FT	Cap tailwheel spindle under retaining wrench
S65-2048253FT	Tailwheel lock spanner wrench
TB-4107GT	Wing flap cap wrench
K65-2700GT	Landing gear retract. strut packing nut
S65-4006288	Retract. strut cyl. packing nut wrench
S65-1018092GT	Cowl flap operating cyl. end wrench
K65-2865GT	Fuel tank strap puller
S65-1004985GT	Hydraulic hand pump pack. nut wrench
S65-1004992GT	Hydraulic hand pump check valve seal wrench
S65-1004900GT	Hydraulic hand pump end wrench
S65-1005506GT	Hydraulic hand pump pack. collar wrench
S65-1004901GT	Hydraulic hand pump liner wrench
S65-14063GT	Gland nut induction tube wrench
S65-14100GT	Sparkplug thread cleaning tool for elbow
K65-2709GT	Axle nut wrench
K65-2914GT	P&W engine drain Allen wrench
K65-2704GT	Propeller installation sheave
S65-1072037GT	Hydraulic pressure reg. valve assy-wrench
K65-2906GT	Tee handle for de-icer system wrench
S65-14118GT	Bus bar nut torque wrench
S65-13227GT	Rudder & elevator torque wrench adapter
S65-13242GT	Engine torque wrench adapter
K65-2714GT	Sparkplug elbow installation wrench
S65-14088GT	Outer wing 1 in. attach. bolt torque wrench
S65-14102GT	Control pedestal wheel nut wrench
K65-2913GT	Heat & exhaust line union socket wrench
S65-14134GT	Landing gear oleo pack. spanner wrench
S65-1103165GT	Nose wheel retract. cyl. torque wrench ext.
S65-1108354GT	Wing flap torque wrench ext.
S65-2104755GT	Landing gear retract. strut cyl. pack. wrench
S65-14119GT	Heat & vent. system wrench
K65-2928GT	Pulling pliers for de-icer boots
K65-2740GT	Tee handle crowfoot wrench
K65-2920GT	Prop. dome hub feathering tool cam 33D50-9 prop
K65-2931GT	Spanner for nose wheel, wing flap, operating struts
K65-2954GT	Main landing gear axle nut wrench
K65-2916GT	Brake plate retainer nut wrench
S65-14135GT	Nose wheel oleo packing nut spanner wrench
S65-1106772GT	Nose wheel hinge link torque wrench ext.
S65-1102886GT	Control panel button installation tool
K65-2901GT	Nacelle fuel sump wrench
K65-2744GT	Friction cylinder wrench
K65-2910GT	Brake plate spacer gage
K65-2911GT	Propeller dome cam wrench
K65-2730GT	Propeller pitch adjustable wrench
S65-14090GT	Attach. bolt inner & outer wing wrench
K65-2951GT	Attach. bolt torque wrench adapter
K65-2902GT	Steering cyl. piston link wrench
S65-1030755GT	Turnbuckle oil tank crowfoot wrench
S65-11070-GT	Ext. rudder & elev. booster torque wrench
S65-1161827GT	Stop nut steering cyl. torque wrench
S65-1161826GT	Nose wheel steering cyl. nut wrench
K65-3886GT	Hydromatic propeller dome wrench
TB-1462-GT	Spanner wrench
S65-3758GT	Hydromatic prop. cylinder wrench
S65-4109GT	Prop. shaft nut wrench
S65-6317GT	4 in. prop. box wrench
S65-17510GT	Dome screwdriver
S65-14057GT	Extension bar for prop. wrench
S65-13266GT	Eng. dynafocal mount torque wrench adapter
S65-14089GT	Torque wrench adapter outer wing 1 in. attach. bolt
S65-2107053GT	Landing gear axle tube collar wrench
Handling Fixtures	
S65-13407HF	Prop. dome work stand
A65-6887HF	Engine assy. stand
S65-6890DP	Engine stand block
S65-6889DP	Engine stand block
S65-6891DP	Engine stand block
TB-4031HF	Outer wing sling
TB-1889HF	Tail support stand
TB-2898HF	Outer wing turnover sling
TB-1891HF	Center wing vertical dolly
TB-4001HF	Cradle tripod for tail section
S65-0274HF	Horizontal stabilizer dolly
S65-13457HF	Main wheels skate dolly
S65-13463HF	Tail weight
TB-4002HF	Main landing gear oleo guard
TB-4025HF	Landing gear installation dolly
TB-1880HF	Nacelle hoist sling
TB-1887HF	Center wing dolly
TB-1891HF	Fuselage hoist sling
S65-2156HF	Center section bracket
S65-3300HF	Jack stand
TB-2647HF	Outer wing sling
TB-4024HF	Center section dolly
S65-5643HF	Towing tail
S65-13435HF	Landing gear platform
S65-13458HF	Hydraulic "A" jack
S65-13459HF	Outer wing horizontal dolly
S65-13460HF	Two outer wings vertical dolly
S65-13461HF	Rudder dolly
S65-13462HF	Elevator dolly
A65-17312HF	Nose wheel tow bar
S65-5073849HF1	Main landing gear oleo protection boot
S65-5073634HF1	Rudder & tab sling
S65-5073637HF1	Vertical stabilizer sling
S65-5073601HF1	Outer wing sling
S65-5073601HF3	Outer wing hoist
S65-5073600HF3	Fuselage tail jack stand
S65-5073600HF2	Fuselage nose stand tripod
S65-5108035HF	Tailskid oleo boot
S65-5073600HF1	Wing jack stand

Handy List of Special Maintenance Tools For Douglas Transports—C-47 to C-54

• With acquisition of various AAF transport craft of Douglas manufacture, numerous operators are frequently faced with the necessity of utilizing special tools for both routine maintenance and specialized overhaul procedure. And since, in many instances, information on interchangeability of specific tools is not to be found in data cases of these surplus craft, considerable trouble is encountered in maintenance activities.

Presented here, for ready reference, is a tabulation showing the relative interchangeability of tools and handling fixtures for Douglas craft ranging from designations C-47 to C-54, inclusive.

The operator may also use the tabulated data when ordering items of this equipment from the manufacturer or in making purchases from government surplus stocks.

This Flying Service Promotion Really Boosts Business

PART VII OF A SERIES

By **CHARLES A. PARKER**, *Flight Service Div. Robinson Aviation, Inc., Teterboro Air Terminal, Teterboro, N. J.*

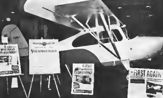
Showing how to stimulate interest in local airport activities, the author presents effective methods of general and direct promotion means and advantages of stressing the short flight.

Considering fixed base operation as a whole, very little money has been spent for sales promotion. And after the CPTP was inaugurated, providing the operator with a "backlog" income, expenditures for advertising and promotion were further lessened. In our postwar aviation, many operators are being faced with keen competition, despite the expended market and the G. I. Bill of Rights with its "silver platter" business. Most lucrative source of business is still the public at large, and operators should not overlook this market, nor minimize the importance of expenditures for advertising and other promotion.

General Promotion Means

Newspaper publicity: It is important that the operator cultivate a close relationship with local press services, winning their full cooperation. Aviation still makes fairly attractive news material—having much more appeal than most types of business enjoy. All possible free publicity should be obtained through current news items and stories of the airport's activities, personalities who have flown there, and other items of interest. And it may be possible to develop a weekly column of news or comment. This is all good advertising and, best of all, at little or no expense. In any news story the press is interested in five essential points—who, what, why, when, and where. Correct full names and addresses are particularly important.

Not only is the publicity angle of general value, but there may be revenue for an occasional charter flight, from any newspaper office. In addition, properly controlled publicity, in the event of accident, may be possible if good relations exist. An interesting illustration of this was shown in the case of an air charter accident involving fatalities. An excellent relationship existed between the charter company and the local newspapers, and all papers were immediately informed of the accident by the operator. Reporters covering the accident were given full information and requested to cooperate. Result was that only one story of six city newspapers carried the operator's name, mentioned only once.



In-town display booths help sell both planes and flying time and in many cases have been found well worth the time the aircraft is tied up

Displays: Utilization of window displays will enable the operator, figuratively speaking, to bring his airport to Main Street. In any community there are opportunities for window type or other public displays. A storekeeper or travel agency with window space may be interested in the attraction that an aviation display will afford. And people with whom the operator spends money may be particularly receptive and glad to cooperate.

There may be instances where the operator can tie his services in with some event featuring aviation—an aviation-theme movie at the local theatre or a model airplane display at a retail store. Also, such days as the anniversary of the Wright brothers' first flight might afford opportunity for some special promotion. In any display the operator should attempt to work in all possible direct advertising relative to his business. Posters, descriptive folders, literature on new airplanes, aerial photos of local points of interest, parts, books on aviation, instruments, and models all make excellent material. A little imagination will go a long way in preparing any display with whatever material the operator has at hand.

More substantial displays may be possible—using actual aircraft—at local fairs, expositions, and auto showrooms. And the operator with any substantial aircraft sales activity may well consider a permanent tie-in with a local automobile dealer for permanent display of the airplane.

Public talks: Another inexpensive means of promotion lies in giving public talks on aviation, which include the operator's activities. This costs nothing and is part of general background promotion that is valuable. Opportunities may be found with clubs, fraternal organizations, and at special dinners, where a good cross-section of responsible persons may be found. Often those in charge of such organizations or functions are looking for speakers to provide an interesting subject, and are anxious for suggestions. Attractive photos or color movies of the operator's activities will be particularly appropriate for such occasions.

Signs: For those airports located off the beaten paths, directional signs assume double importance. Sometimes people will not put themselves out to find an airport remotely located. The answer is, of course, to put up signs. In some instances the town or city may assist the operator—particularly so if the airport is of municipal origin.

Once the trade is at the field, it is good business to describe, by sign, the operator's services, and particularly any aircraft dealership he may represent. Dealership advertising is especially desirable, since it ties in the operator's activity with practices with which the public is readily familiar, namely, those of the automobile dealer. Thus, the gap of understanding will be narrowed down and the operator's activities more readily accepted.

But it must be remembered that directional descriptive signs must be attractive and so maintained at all times.

Satisfied customers: These constitute one of the most valuable and inexpensive sales aids for the operator, and should remain a prime consideration.

Direct Promotion

Personal contact: For selling aviation, the most valuable effort is direct contact. This factor makes it possible to answer the wide variety of questions which the uninformed may wish to have answered, and hence is a means for correcting many misconceptions that so many people entertain regarding flying. And, it is the medium through which the prospect can be personally asked to sign up or give his order.

Utilization of window displays will enable the operator, figuratively speaking, to bring his airport to Main Street . . . and people with whom the operator spends money may be particularly receptive and glad to cooperate

Direct selling may be done by the manager, a pilot, or mechanic, but, better still, by a salesman specially hired for the purpose. However, everybody—from the mechanic's helper to the owner—should sell the business at all times. This effort cannot help but contribute to the eventual improvement of the enterprise as a whole.

But it is necessary for anyone involved in selling to think and talk on the right basis. Here are some practical sales points for all who participate:

a. Talk in the prospect's language. Look at the product from his point of view.

b. Never argue with a prospect.

c. Don't knock a competitor.

d. Take a hint from the average gas station attendant—be pleasant and agreeable. Make the airport a friendly place.

e. Remember that a continued customer is desired, not a one-time user. Build confidence by talking and acting on a sound basis.

f. Don't let anyone leave the airport thinking that flying is still a fly-by-night proposition. Counteract expressions of doubt by convincing and constructive arguments.

g. Bear in mind that effort doesn't end with the sale. See that customers are properly served after being sold.

Sales literature: It will be decidedly advantageous to use descriptive literature. This is the operator's salesman-in-print. Such literature is excellent over-the-counter material, and provides something that the prospect can take away with him to peruse further. Supplementing personal contact, suitable literature is an excellent number-one step in the sales effort right at the airport. The material may vary from a simple comprehensive folder covering all services, to a highly specialized presentation. For example, literature may be prepared covering aspects of instruction and rental flying and lead up to eventual ownership. Other material may be devoted entirely to air charter, air tours, and sightseeing.

One company, working in an area covering approximately 800,000 people, developed a twelve-page booklet solely on instruction and private flying. Here the charter potential was deemed sufficient so that a special four-page folder was devoted to this activity and sightseeing. A third piece was developed covering shop services for current and prospective aircraft owners. And a fourth was produced for periodic listing of used aircraft for sale. In addi-

(*Turn to page 142*)

CAA Work Plan Settled

Big fuss over CAA's proposal to maintain a strong stock of war-surplus parts and do its own repair work on its fleet of 231 war-surplus airplanes, instead of contracting the work to service industry was finally compromised in Congress.

CAA had planned to set up three parts warehouses and open its own shops, and had asked Congress for $2,000,000 for the purpose. Aeronautical Training Society, Aircraft Industries Assn, Air Transport Assn, Assn of Airport Executives, NATA, NAA, and other groups immediately objected, charging Government competition.

Rep Jennings Randolph offered an amendment to the Commerce Department's 1947 appropriation bill, which included the CAA request, requiring CAA to contract all jobs over $100, scaling down the $2,000,000-request, and limiting parts warehouses to one instead of three. The House passed it, but the Senate bill would have permitted CAA to do all its own repairs, except jobs for which it would have to obtain more than $100 worth of parts outside of its own stockpile.

Opposition continued, and the Senate-House conference committee, pulling the two bills together, finally limits CAA to one major storage base, reduces the appropriation to $1,503,000, and permits CAA to do its own repair jobs up to $200. Above that figure, jobs must be let by bid to private contractors.

MISSOURI'S MODEL AIRPARK

Scene at dedication of model airpark at Eldon, Mo., which drew large gathering of notables and personal flyers in campaign for more similar landing facilities for non-schedule flying. Photo was taken from interior of modern administration building built by Butler Mfg. Co.

First Region—Pittsburgh has eleven floatplane bases. With little flat country for airports private owners and operators are turning to smooth rivers . . . Merrimac Valley Air Service, Lowell, Mass. has built seaplane base . . . Ed Evans has opened seaplane base at Stamford, Conn . . . Bob Tinney, ex-Navy pilot and veteran seaplane operator, is opening base at Clark's Cove, New Bedford, Mass . . . Sall Air, headed by Robert W Tucker, has opened seaplane base at Folly Landing, Cowassett, Near East Greenwich, R. I . . . N. Y.'s downtown seaplane bases are being opened again with Gulf Oil operating Wall St Downtown Skyport and 23rd St. base in East River, Veteran Dennis Caterino is on Hudson River at 200th St. . . . Agriculture Dept will resume aerial mapping contracts with private operators later this year. About 20 firms contracted for this work before the war and most of them have announced intention to resume the work . . . Regional offices of the CAA are now authorized to award final approvals to flying schools, repair stations, ground schools, mechanic schools, and parachute rigging schools without approval from Washington . . . A bill exempting aerial taxi operators of aircraft accommodating less than ten passengers including pilot from the 15% transportation tax has been introduced by Senator Warren G. Magnuson (D Wash.) . . . According to Aero Insurance Underwriters farmer pilots should not fly crop dusting, instead should leave it to the professionals . . . New Bedford Aviation, Inc. now opening airport service at South Dartmouth, Mass. will sell and service Piper Cubs, Republic Seabees and Edo floats. Also provided is charter service, flight instruction, sight-seeing flights and aerial photography.

Second Region—Announcement comes that Miami's All American Air Maneuvers of 1947 will be held Jan. 10-12. Exhibition of aviation products known as 'Aviation of Tomorrow' will be held Jan. 6-16 in Miami auditorium in Bayfront Park . . . Wm. T. Piper, pres., Piper Aircraft Corp., recently spoke at luncheon of Columbia (S. C.) Aero Club on responsibilities of public, pilots and manufacturers in new era of private flying stressing necessity for more landing strips and small airports located near towns and small cities . . . Beverly Howard, pres. of Hawthorne Flying Service, chain of four airports in Southeast, was awarded first prize of $5,000 by Andrew J Haire, publisher of 'Airports,' for best all around improvement and efficient operation of small airports . . . An air "practice teaching" project to develop better flight instruction methods and a code for measuring quality of such instruction, is being conducted at University of Tennessee under CAA auspices . . . A pack of 55 racing greyhounds was flown 1,200 mi from Miami to New York in 6 hr and 35 min in a Douglas C-47 chartered by their owners from Universal Airlines. The dogs confined in 15 wood and wire net crates secured to floor of aircraft's (Turn to page 141)

AS THE OPERATORS SEE IT

QUESTION 4—Which of these sources of new business do you consider the best: (A) Customer goodwill, (B) bill boards, or (C) local newspaper advertising? What has been your experience with these media? Have you used successfully any other method for attracting business to the airport?—D. H.

Answer: "Customer goodwill and local newspaper advertising have gone hand in hand—we've used consistent newspaper advertising to get prospects' attention, then returned their goodwill by giving the kind of service we advertise. We have also found downtown store window displays—well tied in with our newspaper ads—to be very good promotion since it gives us, in effect, a showroom right in the heart of town."—J. D. K.

Readers Are Invited to Answer

Question 5—In the initial step of our base set-up we are confronted with problem of site expense. Do you consider that a main highway passing an airport is of sufficient advantage to compensate for relatively high tax charges on the land as compared to a location on a secondary road where there is little through-traffic but where taxes are considerably lower?—A. M.

CONDUCTED BY FRANK ROCKETT

An Evaluation Of Hyperbolic Radio Avigation

Presenting a comparison of ranges and of geometric and timing accuracies of loran, gee, and just-released decca systems.

Radio avigation services can provide worldwide facilities that will be less subject to interference by weather than celestial or terrestrial navigation. The only question is which of the several systems that have been developed, or combination of systems, to adopt as standard. Recently released information on the two British techniques of gee and decca, plus already published data on American loran, enable us to evaluate the several systems.

For regularly scheduled long distance flights a means of avigation that permits the pilot to fly the air currents is needed. For this type of long distance flying, radio beams are inadequate. However, hyperbolic radio lines of position, because they provide a distinct coordinate system comparable to the coordinates of latitude and longitude, constitute the required type of system.

Foremost advantage of these radio coordinates over terrestrial coordinates is that they are physically real, not just arbitrary lines on maps that must be indirectly inferred from celestial or terrestrial observations which can be hampered by weather. By means of radio receivers the radio coordinates can be "felt" and followed at all times.

The five systems described in Table I have many features in common. As shown in Fig. 1, they all generate hyperbolic coordinates. Their geometric accuracies (that is, the accuracy with which one can locate a point on a map once the proper lines of position have been determined—it is dependent upon the spacing between lines of position of a family and upon the angle of cut between pairs of families) are determined by the length and orientation of their base lines. Although decca is the only system currently using automatically indicating meters which function without attention from an avigator, all systems can be engineered to operate similar instruments at both the pilot's and the avigator's positions with very little additional bulk and weight, and will probably be so modified for commercial use. Airborne receivers for each system can be constructed within a 30-lb limit.

The basic principle on which the hyperbolic systems operate is the measurement at the airplane of the time difference between the arrival of several signals that were transmitted simultaneously from different transmitters of accurately known locations. In all forms of loran and in gee the signal is a regularly repeated pulse; in decca it is a sine wave. To explain accurately the distinctions between the several systems would require going needlessly into their methods of operation. Here we are primarily concerned with the avigational services that each system can provide.

With gee and decca, only one observation is necessary because each master transmitter operates two slaves, as shown in Fig. 1A; the signals from both slaves can be compared to the master (Turn to page 149)

TABLE I—Operational Data of Various Hyperbolic Avigational Systems

Type System	Rate and Accuracy nautical		Base Line mi.	Pulse Length microseconds	Radio Carrier Frequency
Standard Loran (loran)	(day time) 700	1	250	50	1.7-2.0 mc
	(nighttime) 1,400	8			
(accuracy comparable to celestial avigation—range over land limited to 200 mi.)					
Sky wave Synchronized Loran (ss-loran)	1,500	1.5	1,400	50	1.7-2.0 mc
(limited to nighttime use)					
Low Frequency Loran (lf-loran)	800	0.01	500	(cycle matching)	about 180 kc
(service both day and night over land and sea, accuracy comparable to trigonometric surveying, experimental)					
Gee	350	0.25	75	5	40-80 mc.
(equally useful over land or sea at day or night)					
Decca	300	0.1	500	(phase difference)	60-120 kc.
(equally useful over land or sea at day or night, extreme range is 1,200 mi.)					

(All figures in round numbers and presented more to indicate orders of magnitude than actual operating conditions.)

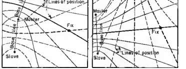


Fig. 1. In gee and decca systems—shown in (A)—each master transmitter controls two slaves while in various forms of loran—shown in (B)—a master has but one slave

FINANCE

Profits Balanced By Reconversion Costs

PART II

By **RAYMOND L. HOADLEY**, *Financial Editor "Aviation"*

Concluding his study of manufacturers' profit-or-loss possibilities this year, our financial analyst swings west to check the financial positions of major airframe producers on the Pacific Coast.

West coast plane manufacturers won't have much in the way of profits to report to stockholders at the year-end. Yet the folks in the front offices don't call it a gloomy outlook for they all expect to show much larger earning power in 1947.

Some companies will show earnings in 1946 although they will be smaller than in recent years. Some, perhaps the majority, will about break even while others already know that this year's operations will end up in the red.

Lockheed happens to be one of those likely to show a profit, the main reason being that this was one of the first of our plane makers to get squared off into commercial production after V-J Day. Today the company's war business has been completely terminated and its $175,000,000 wartime credit arrangement cancelled.

Furthermore, Lockheed has its financial affairs in apple pie order to meet all peacetime requirements. Working capital stands at $42,600,000 and bank credits of $40,000,000 are available if needed for such purposes as the estimated $10,000,000 capital expenditures over the next five years.

And, incidentally, financial vice-president C. A. Barker, Jr. takes a good deal of satisfaction in the fact that plant and equipment costing $30,000,000 are now written off so that today all facilities, emergency or non-emergency, are carried on the books at less than $4,000,000.

Lockheed officials venture no guesses on 1946 results except to say they will be "in the black." As a matter of fact, Lockheed could show quite sizable profits but the management has chosen the conservative course and plans to charge off some heavy plant rearrangement expense against earnings.

In the matter of dividends too, Lockheed leans to the conservative side. Quarterly 50¢ dividends have been paid for some little time back. However dividend action will not be taken in the current quarter. Rather, directors will wait until late in the year before deciding how much more to disburse in 1946. Even though total payments for the year may come up to the usual $2 a share, Pres. Robert Gross doesn't want stockholders to assume the concern is on a regular 50¢ quarterly basis.

Unfilled orders total $290,000,000 with new orders, so far this year, keeping pace with deliveries. Lockheed never had any military business before the war. Now, however, its government orders stand at $155,000,000 and include the P-80 Shooting Star jet fighter with deliveries running to March, 1948. And company officials feel this famous plane has lots more "stretch" left in it.

Other government orders include a large one for the P2V Neptune—said to have the longest range of any plane yet built—and an order for two double-deck Constitutions, costing $10,000,000 apiece.

In the commercial field Lockheed has the Constellation and the Saturn, the latter a newly-announced feederliner (see page 93). Some 70-odd Constellations will be delivered to various airlines this year while production on the Saturn is scheduled to start early next year. An intensive effort will be made to sell this plane to Latin America and other export markets.

Rising costs should not be the headache for Lockheed it is bound to be for some reconverting firms. All government contracts provide for rising costs, and prices of commercial planes have been upped in line with higher costs of labor and materials. The Constellation, for example, now costs $810,000 against $675,000 when civilian production was resumed.

Douglas Aircraft started off the current year with a bang, earning $1.85 a share in the first quarter. These results, however, are a bit deceptive as company officials expect they will about break even on the full year's operations. Douglas has adopted the conservative policy of charging against profits all production costs of aircraft to be delivered this year. That means there will be losses in subsequent quarters that would not have appeared had initial production costs been spread over the life of a given model like the new DC-6.

Unfilled orders approximate $170,000,000, of which $100,000,000 is commercial volume. Military orders include experimental work, production of the giant C-74 Globemaster for the Army and a $50,000,000 postwar Navy order for dive bombers.

In the commercial field Douglas has the DC-3C "Executive" plane, the DC-4 and the DC-6 which should be in volume production this summer. The company feels there are real possibilities in the development of a commercial plane built around its XB-42 twin engine bomber with its motorless wings. The advantages in payload, passenger and cargo handling and engine servicing are thought to be sufficiently promising to warrant development of a non-military model.

One of the strong points about Douglas for years has been its financial position. Net working capital available for financing production, development and experimental work amounts to about $65,000,000.

Pres. Donald Douglas is not one to gloss over any disturbing factors there may be in the outlook. Some contemporaries claim he is prone to over-emphasize the dark side of things. Perhaps this is because Douglas always maintains its prime position in the industry no matter how disturbed its head may be over the problems with which he has to wrestle.

At the annual meeting this year he observed that our commercial airlines were rapidly getting "over-seated". A single plane of the DC-6 type, he pointed out, can carry as many passengers between distant points in a month as a

(*Turn to page 146*)

THE NORTHROP XB-35 FLYING WING SUPERBOMBER

By JOHN K. NORTHROP, *President, Northrop Aircraft, Inc*

When the XB-35 "All Wing" Army bomber flew for the first time the morning of June 25, 1946, it represented substantial progress in the development of this type of aircraft from the time the first Northrop "wing" of 30-ft span was flown in 1929, to the 176-ft. span and 100 ton size of the present 12,000 hp super-bomber. And we believe the flight of the XB-35 gives the American aircraft industry a clear claim to leadership in the current international race to develop "flying wing" type aircraft

In discussing the "wing" or "all wing" type airplane it is important that we clearly state our terms What do we mean by an "all wing" airplane? And why are we building airplanes of as nearly pure wing form as is practicable?

By all wing we mean an airplane in which all necessary functions of flight stability and control, and all other useful functions are accomplished without employment of any non lifting surfaces or bodies external to the wing contour, and it is obvious that a wing must be more efficient than a wing plus fuselage, tail surfaces, etc

The flying wing or tailless type airplane is not necessarily an all wing airplane. The history of the aviation industry is replete with examples of the tailless plane, such as the Burgess-Dunn, Hill, Lippisch, etc These have usually incorporated a fuselage with auxiliary control surfaces separate from the wing. A more modern example of such a plane is the German Me 163, in which the horizontal tail surface is eliminated through use of a sweptback wing mounted on a stubby fuselage with vertical fin and rudder A very close approach to the true all wing airplane was achieved in Germany by the Horten brothers as shown by the article beginning on page 65 In their designs an effort was made to fully enclose the pilot and engine within the wing contour, as has been the Northrop goal from the inception of the all wing program in 1923

First Northrop flying wing venture, originally conceived in 1923 and flown in 1929 Note that even in this craft pilot was housed within wing which featured sweepback, radical degree of taper and unusually thick center section

While we have never yet succeeded in building a "pure" wing, inasmuch as there have always been such unavoidable protuberances as propeller shaft housings, gun turrets, etc., still the XB-35 does closely approach the all wing ideal in that it has no fuselage whatever, no external control surfaces other than those which are incorporated within the wing itself, and no engine nacelles, the engines being completely submerged within the wing

Development of the XB-35 design resulted from our effort to produce a very heavy bomber of superior performance And our continuing objective is to build the most efficient airplane for any given purpose In previous articles (AVIATION, March 29, 1930 and December 1941) the author has outlined in considerable detail the factors which favor development of the all wing type airplane, especially for large load carrying aircraft For many purposes it seems inevitable that an unbiased design study will prove that the all wing plane is the best solution to the problem.

In the past there have been serious stability and control difficulties inherent in development of the wing type air

SPECIAL FLYING WING SECTION

craft which have so discouraged some designers as to induce them to solve the problem in a more conventional way. Yet the ideal of the true wing airplane, in which all non-lifting elements are suppressed, has continued to be the goal of many aviation pioneers.

A quick review of Northrop experience with wing types shows that the XB-35 is not of itself a radical design, but is rather a normal development of the step-by-step program carried on for almost 25 yr. The first Northrop all wing airplane was conceived in 1923 and flown in 1929. Although it incorporated conventional controls its family resemblance to the XB-35 is otherwise strong. The pilot and engine were housed almost completely within the wing, which featured sweepback, a radical degree of taper, and an unusually thick center section. Taper ratio was more than two to one and the wing section thickness at the root was about one third the chord. On the XB-35 the taper ratio is approximately four to one and the wing root thickness to chord ratio is about 20%. As with the XB-35, our first attempt at an all wing plane was driven by a pusher propeller through an extension shaft, and was an all metal airplane incorporating stressed-skin structure.

In 1939 the present Northrop Aircraft, Inc., was formed and design started at once on the N1M, the first true all wing airplane, which was flown in July, 1940. The N1M had two engines completely submerged in the wing with the pilot's compartment located between them. No external stabilizing or control surfaces were used, and the only departure from the all wing ideal was in the use of small propeller shaft housings. This plane made more than 200 successful flights and served as a highly effective flying laboratory for determining the variable effect of changes in sweepback, dihedral, CG position and control surface configuration. Two 65-hp. Lycoming engines were first used in the N1M and later exchanged for two 120 hp. Franklins. Span of the N1M was 38 ft, length 17 ft, wing area 300 sq ft, wing taper from a root chord of 168 in. to 24 in. at the tip, with maximum thickness of the wing 36 in. As development of this airplane progressed it was found possible to substitute straight wing tips for the drooped tips originally incorporated, without loss of stability.

The Northrop N2M carried the Army designation XP-56, and was an experimental single seat fighter with a small fuselage mounted on a swept-back wing. Although this plane was tailless and termed a flying wing, it did not approach the all wing ideal as it employed a fuselage with a rather large vertical stabilizer mounted at the rear, just forward of the co-axial contra-rotating pusher propeller. The vertical fin surface was needed to stabilize the fuselage, a substantial portion of which extended ahead of the CG. The R-2800 air cooled engine was submerged in the fuselage behind the pilot's cockpit.

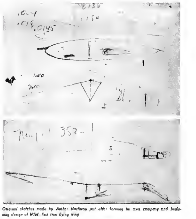
This plane was something of a milestone itself as it is believed to have been the first welded all-magnesium airplane ever built. It also incorporated a novel rudder control which made use of air bellows to operate wingtip split flaps for directional control. This control method gave low rudder pedal forces and was quite satisfactory. Control of the split flap bellows was achieved by rafting air to or from the bellows by means of wingtip venturis. Two of these planes were built.

Meanwhile, in September 1941, success of the N1M flight program had been called to the attention of the Army Air Forces. General H. H. "Hap" Arnold, Ass't Secty. of War Robert Lovett, and Maj. Gen. Oliver P. Echols were among those who had the foresight to recognize the possible impact of all wing type aircraft on future aerial tactics and to suggest that we study the possibility of development of long range bombardment aircraft incorporating these principles. Three months later Northrop Aircraft submitted preliminary layouts and performance data on such a design and a contract for two experimental aircraft, designated XB-35, was awarded in 1942.

To provide scale model flight research data four N9M models of 60-ft span were built and flown. These planes duplicated, as nearly as possible, the flight characteristics of the XB-35. The first three of the N9M's were powered with two 275 hp. Menasco engines each, while the fourth, designated N9M-B, was powered with two 300 hp. Franklin engines. Hundreds of hours of flight testing were recorded on the N9M's. Although they were little more than one third the size of the projected XB-35 in every comparable dimension, the N9M's, with a weight of 7,100 lb, were only one twenty third as heavy as the XB-35.

Following development of the XP-56 an experimental contract was awarded for a high speed twin jet pursuit of wing type with the pilot to be carried in a prone position. A flying mock-up glider was designed, known simply as Project 12, and three were built and flown, followed by the full scale jet fighter, the welded all magnesium XP-79 "Flying Ram". Further development of this project was delayed by the end of the war but is now progressing. With a top speed of more than 500 mph, this fighter showed great promise. As in the XP-56 air bellows-operated split flap wingtip rudders were used for directional control. Two vertical fins were mounted on the jet center lines near the wing trailing edge to provide directional stability. However, a single fin of smaller dimensions was planned for later installation.

Adaptation of the Northrop wing design to various military uses, prior to flight testing the XB-35 bomber, included the design, testing, and manufacture of a series of flying wing buzzbombs. First of these was a twin jet type with a single vertical stabilizing fin. A later version was of much cleaner design, enclosing the war-head within the wing and incorporating a single jet unit of the German resonance-jet type. Many of these missiles were built and test flown, though none saw combat. Development of jet propelled wing weapons, prototypes for future missiles of longer range and higher speed completed the Northrop engineering program on all wing aircraft leading up to the successful flight of the XB-35.



Original sketches made by Author Northrop just after forming his own company and beginning design of N1M, first true flying wing

Our engineering staff now has literally millions of man hours of all wing design experience, and our test pilots have amassed many hundreds of hours of wing flight time. Even so, in evaluating the XB-35 we should bear in mind that it is the first all wing big bomber and is by all odds the most radical large airplane yet flown. While the first flights of the XB-35 have been almost phenomenally successful, even conventional large airplanes have frequently experienced prototype difficulties, which should not be considered discouraging if encountered in the prototype XB-35.

Here is N1M on first flight at Muroc Lake, Calif., presaging recent flight tests of its huge successor XB-35. Straight wingtips were later installed as craft's inherent stability made these droop tips unnecessary.

■ In the seclusion of his cabin at picturesque Lake Arrowhead, Jack Northrop spurned rest and sun tan to write this article in longhand during the July 4th holiday. AVIATION's correspondent picked up the completed manuscript on the following day to rush it to Los Angeles for transcription and transmission to New York. The author shared our eagerness to catch our deadline because it has been our privilege to present his views whenever a milestone was passed in flying wing development, as exemplified by his previous articles in AVIATION for March 29, 1930 and December, 1941.

The 1930 article was written more than a year after the test flights of the 1928 machine; this one was written a little over a week after the first flight of the XB-35.

Because of his supreme modesty, no mention is made in the article of the author's lifetime of contributions to aircraft design. His genius is unique in aeronautical engineering. Perhaps no other designer in this field has played such a vital part in such a wide range of aviation developments. Associated with Allan Lockheed in the early days of post World War I aircraft design, Jack Northrop is credited with detailed design of the famous Lockheed Vega, first successful commercial plane with monocoque fuselage. Through later association with United Aircraft and Douglas he participated in the design development of a whole family of transports.

All modern stressed-skin metal airplanes follow his pioneering work on the 1928-30 Northrop Flying Wing, which was of smooth stressed-skin multi-cellular construction. His Alpha, Beta, Gamma, Delta, and A-17 all proved the stressed skin structure in notable speed and long range flights throughout the world.

Often accused of being a "nut" on flying wings, Northrop's record proves otherwise. Not only were the Alpha through Delta aircraft of conventional type, but his wartime operations were largely devoted to the N3PB seaplane and the P-61 night fighter of conventional design.

With development of the all wing plane which eliminates external control surfaces, Northrop has achieved a goal long sought by engineers—and at the same time he has made other radical and revolutionary contributions. In the field of control, for example, he perfected the "elevon", he was first to apply the split trailing edge flap to modern planes and demonstrate its practicability, he developed the retractable aileron and full-span flap. In the field of structures he has been outstanding in perfection of the multicellular stressed skin construction, he pioneered the use of spot welding for structural parts, and was first to design an all-magnesium plane.

Now, with the successful flights of the XB-35, the world of flight finds daring new advances within its grasp. Some observers believe, on the basis of known XB-35 performances, that we will soon see 100-passenger transport planes cruising at 500 mph, that we will have wing type freight planes capable of cutting present ton-mile costs in half, that we are on the threshold of that inevitable era in which a bombing plane will be able to take off from any spot in the world, bomb any other spot, and return to its starting point nonstop. Even now it is theoretically possible for the XB-35 to fly a small bomb load to any part of Europe and return to the U. S. nonstop. The XB-35 should even be capable of a "flight around the pole" nonstop from a point in the U. S. and return, which would be the first nonstop "around the world" flight and would literally stop the clock and successfully race the sun if the direction was from east to west. Flying from west to east the XB-35 is easily capable of taking off from New York, fly over Moscow and continue nonstop to Alaska.

The all wing plane gives promise of greatest range, greatest load carrying ability, and highest speed in the supersonic range. And America now clearly leads in the race to develop the all wing plane because of the personal genius of her outstanding pioneer in this field, John K. Northrop.—*The Editors*

SPECIAL FLYING WING SECTION

Since the XB-35 represents a significant milepost in bomber development we may well seek to define at this point the current outlook for further development and application of the all wing design.

We do not think that the wing type is limited exclusively to very large airplanes. Special applications such as the XP-79 prone-pilot fighter, and the JB 1A type jet bomb, show that the tailless wing, very nearly in its "pure" form, may be adapted to some very small aircraft. For passenger carrying airplanes we believe a weight bracket of roughly 50,000 to 500,000 lb can be established, within which we expect to see all wing bombers and transports developed.

Whether commercial air transport planes weighing 500,000 lb. or more will ever be economically sound we do not now know, but engineering studies indicate that we can build planes of such size without serious structural penalty. There is, of course, no known aerodynamic penalty connected with increased size as such.

As for speed, all our research to date indicates that the all wing type aircraft suffers less than conventional types from the shock effect encountered in the transsonic speed range. We believe that the wing type is suitable for development in the transsonic and supersonic speed ranges, and that its upper speed limit, in certain configurations, will be greater than that of more conventional aircraft.

Certain radical developments, such as the Navy's XF5U 1 Chance Vought "Flying Pancake" (detailed on page 62) have resulted in the conjecture that a marked change in the form of future flying wings, away from present configurations, may be expected. We do not anticipate any such change in connection with planes designed for optimum aerodynamic efficiency. It is likely that proportional wing thickness will be substantially reduced as speeds go higher, resulting in relatively greater wing chord, with which may come reduced aspect ratio and increased sweepback. But we do not expect to see substantial variation from our present pattern within the next few years.

There is strong evidence that the wing type will find its greatest application as a carrier of air freight. The ability to dispose loads spanwise through the wing is efficient both structurally and operationally. A number of doors in the lower wing surface would provide easier access to all cargo compartments and

Northrop N2M, experimental fighter carried Army designation XP-56 and is first welded all magnesium craft ever built.

therefore more rapid loading and unloading than is possible on conventional aircraft. And the freight plane can be built without such protuberances as gun turrets and gun sighting stations, thus greatly increasing over-all efficiency.

There is a tendency to discount the adaptability of the wing type to passenger carrying because of the necessity of locating the cabin within the central portion of the wing, where the passengers might object to being "cooped up". Actually there are a number of advantages in the all wing type as a passenger carrier. A slight bulging of the lower wing surface would provide generous side and downward window area. And it will be relatively simple to give most of the passengers good forward vision directly ahead which is quite impossible in conventional aircraft.

Actually it has been fully demonstrated that, except for first timers, most passengers would rather play cards, read a book, or look at a movie than look out the window in flight. In the "all wing" type plane the large rectangular central cabin lends itself ideally to showing of motion pictures in flight, to easy grouping of passengers for cards or meals, and to ease of movement and a sense of spaciousness generally lacking in more conventional aircraft.

In the XB-35 it has been necessary to make many compromises with the ideal and to accept many structural and aerodynamic penalties because of the tactical nature of the aircraft. Provision of gun turrets, of eight large open bomb bays, and the large pressurized crew compartment have all contributed weight and drag which commercial versions of the same plane would not have. Installation of the submerged radial engines, with complex air and exhaust ducting systems, remote propeller mountings and long drive shafts all exact a heavy penalty by comparison with the jet units which we believe are the ideal powerplants for use in all wing aircraft.

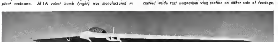
The XB-35, although just flown for the first time, is already four years old from a design standpoint. Starting from scratch we can now design and build a much more efficient airplane. For example, while 75S dural is currently superior to magnesium by a substantial margin for most structural purposes, it is likely that aircraft of still higher speeds will benefit through use of thick skins of magnesium alloy sheeting. Such a surface skin can be given a smoother form than present sheet-stiffened combinations, resulting in improved aerodynamic and structural efficiency.

The present XB 35 incorporates many noteworthy design features. The plane is classified as an all metal, full cantilever tailless, four-engine bombardment airplane of true all wing design, with no exposed stabilizing or control surfaces other than those incorporated within the form of the wing itself. Crew capacity is 15 men, normal crew consisting of nine and relief crew six men. Design weight empty is 89,000 lb., normal gross weight is 162,000 lb., and overload gross weight is 209,000 lb. Span of the XB-35 is 172 ft., length 53 ft., height 20 ft. 1 in., root chord 37½ ft. and tip chord 9 ft. 4 in. Propeller clearance is 6 ft. 8 in.

Power is supplied by four Pratt & Whitney Wasp Major radial engines, one pair each of R-4360-17 and R-4360-21 series, each equipped with two single stage General Electric turbosupercharg ers, with a normal rating of 2,500 hp., and military rating of 3,000 hp at unspecified (censored) altitude.

XP-79 Flying Ram, all-magnesium prone-pilot craft powered by two Westinghouse 19 B axial flow turbojets. Single vertical fin was planned for production model but air bellows-operated split flap wingtip rudders would be maintained.

First Northrop robot bomb (left) was powered by two General Electric turbojets. Warheads were carried in bulges just outboard of powerplant enclosure. JB 1A robot bomb (right) was manufactured in quantity by Northrop for AAF testing. German type pulse jet engine as used in V-1 buzzbombs supplied power. 2 ton explosive charge was carried inside cast magnesium wing section on either side of fuselage.



One of four N9M's built and flown to provide flight research data for XB 35. Though a little over one-third size of XB 35 in every comparable dimension, weight of 7,100 lb. is but one twenty-third that of XB-35, which has gross overload weight of more than 100 tons.

Propellers are eight-bladed coaxial Superhydromatic Hamilton Standards 15 ft. 4 in. diameter. Pitch can be reversed for braking action to reduce landing run. Landing gear is fully retractable tricycle type with dual wheels 5 ft. 6 in. in diameter on the main gear and a single wheel, 4 ft. 8 in. in diameter on the nose gear.

Stability of the XB 35 has not been the problem some have imagined. Of course longitudinal stability of a wing is essentially no great problem if the CG is properly located with respect to the CL and proper airfoil sections are used. On the XB 35, and other wing type aircraft, sweepback is more a requirement of proper balance than of stability. Allowable shift of CG on the XB 35 is surprisingly large. One serious longitudinal stability problem of all sweptback wings is their tendency to stall at the tips first at high angles of attack, thus further aggravating the stall by inducing a nose-up effect.

This is eliminated on the XB 35 by providing tip slots with automatically operated doors which open when the speed drops below 140 mph., bringing the slots into action and maintaining lift at the tips beyond the angle at which the main body of the wing stalls. Stall tests of this device on the N9M have proved entirely satisfactory.

Lateral stability of the wing results from 1 deg. of built-in dihedral and from the effective dihedral resulting from sweepback.

Directional stability is also to a considerable degree a function of sweepback, which gives a "weather-vane" effect which would of itself be adequate for all practical purposes, though perhaps not meeting current stability criteria. However, without providing vertical stabilizing surfaces an ample vertical fin effect is obtained from the four propellers which, located well aft of the CG, have a directionally stabilizing action whether under power or windmilling. Even if all propellers were fully feathered in a power-off glide there would be considerable vertical fin effect from the total area of the 32 propeller blades.

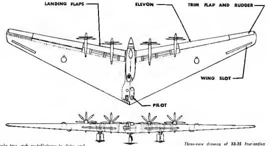
On the jet powered version of the XB-35 small vertical fins will be provided at the trailing edge to give the degree of directional stability to which the pilot is accustomed. Actually, with two engines out on the same side, the XB 35 will stabilize itself in a yawed attitude due to the inherent directional stability of the sweptback wing, without application of corrective rudder. Such a flight attitude adds very little additional drag and therefore is practical only on this type aircraft.

Flight controls on the XB-35 are built into the wing trailing edge. Trim flaps are mounted outboard of the elevons at the wingtips, and are used to trim the plane longitudinally. Rudders, of split flap type, are mounted on the trim flaps and are power-operated to provide drag as required for directional control. The elevons, inboard of the trim flaps, are actuated together for elevator effect and differentially for aileron action. Incidentally, the term "elevon" was originally coined in the Northrop engineering department and applied to the original all wing N1M airplane.

Landing flaps occupy the inboard section of the trailing edge. The pitching moment they impose is counteracted by the trim flaps at the wing tips, the tip flaps moving up as the landing flaps are lowered. While it is not currently possible to obtain as high a trimmed CLmax on the XB-35 as on a conventional airplane, the minimum drag is so much less than conventional that the ratio of CLmax/CDmin is improved by about 50%. Further research on the use of lift devices of various types, as applied to the all wing airplane, shows considerable promise.

An important feature of XB 35 control is the 100% hydraulic boost. The pilot works against an artificial pneumatic loading system which gives him a sense of speed and acceleration and prevents him from overloading the airplane stucturally. An electric standby control system is provided in event of hydraulic failure. The hydraulic system is of medium high pressure type—approximately 2,000-lb pressure—and employs 92 hp from the main power supply to operate the eight hydraulic pumps.

The electrical system is of the 400 cycle, three phase, 208 v variety, one of



Three-view drawing of XB-35 four-engine superbomber representing latest development in Northrop flying wing program. Possibilities for commercial adaptation of this type craft are discussed in accompanying article by the designer.

only two such installations to date, and the first to be flown. It is used to operate landing gear, landing gear doors, bomb bay doors, gun turrets, and other equipment. Four alternators have a capacity of 120 kw/hr., or more than enough to supply normal electric service to 1,000 ordinary homes.

Structurally the XB 35 incorporates three major elements in one homogeneous unit. The crew nacelle is a semi-monocoque structure at the wing center, basically rectangular in cross section, and framed to withstand pressurization loads. Plexiglas windows vary in thickness from ⅜ to 11/16 in. As in all Northrop aircraft structures since the first wing of 1929 major loads are carried by the stressed skin which, in the XB 35, is mostly of 75S alloy, and which varies from a minimum of .020 thickness to a maximum of .091 around the leading edge section. The inner wing section, extending from the crew nacelle to outboard of the engines, incorporates two main spars with the upper surface of the wing stabilized by hat section 75S stringers. The under surface of the inner wing section is almost completely open between the front and rear spars, with roll-away doors for the four bomb bays on each side of the crew compartment. The nose portion of the wing forward of the front spar, acts as the torque section. The outboard wing section also incorporates two main spar members but is otherwise semi-monocoque with upper and lower surface skin stabilized by hat section 75S stringers.

First of three XB-35's under construction showing wing profile at tip, and area aft of rear spar for installation of "elevons"

Inboard engines are mounted forward of the front spar, in the leading edge section, and drive their propellers through a three-section drive shaft, each section being about 8 ft. long. Outboard engines are located between front and rear spars and drive their propellers through two-section shafts, all shafts turning at engine speed. Propeller speed reduction is handled in the propeller gear boxes, on which the propellers are mounted. The shafts and gear boxes were engineered, developed and tested by Pratt & Whitney. The complete propeller and drive system units were given further extensive testing by our own engineers on a test stand simulating the engine section of the

SPECIAL FLYING WING SECTION

First three of 15 Northrop XB 35 superbombers outside plant at Hawthorne Calif. Ship No 1, in center, recently made successful maiden flight and is continuing flight tests at Muroc Army Air Base

XB-35 wing. The gear boxes are mounted on cantilever structural members which extend back from the rear wing spar.

Mounting the engines within the wing complicates the problem of handling cooling air for various powerplant elements. In order to reduce the size and complexity of the various ducts required for engine cooling, oil coolers, intercoolers, carburetor air intake, etc., we have provided a single "plenum chamber" in the leading edge of each half of the wing. We believe this is the first time that a plenum chamber has been applied to aircraft design. The result is a single compartment under considerable ram pressure, in the walls of which are installed oil coolers, inter-coolers and other similar cooling elements. Installation of jet power units will greatly simplify problems of air ducting met on this prototype plane.

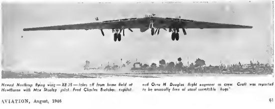
Flight test instrumentation on our first XB 35 is most comprehensive. Automatic recording devices take a permanent record of all significant flight and engine instrument readings throughout the test program. In addition, on the first flight and during the early phases of flight testing, instrument readings have been transmitted by television from the XB 35 in flight to an accompanying P 61 plane. This is believed to be the first air-to-air television transmission of such data.

When the XB 35 made its first flight the crew was already thoroughly experienced, both in XB 35 operation and in personal teamwork. The pilot, Max Stanley, has had extensive flying experience in large transport aircraft and is among the top two or three men in the U. S. in total flying wing time. Fred Charles Bretcher, copilot, has had hundreds of hours of flying time on Army B-29's and B-32's, plus a familiarization program on the N9M wing. Orva H. Douglas, flight engineer, designed and operated our engine test stand, and had personally given each Wasp Major engine about 150 hr. of run in time which simulated XB 35 flight operation. All three of these men spent many hours in taxi tests of the XB 35, including a number of high speed taxi runs prior to take off, reaching a speed of 115 mph. during this period of checking engines, propellers, brakes, controls and instruments.

A great team of technical experts has contributed to the success of the XB 35, but among those who have been closest to the project are: Dr. Theodore von Karman, aerodynamic consultant; Dr. W. R. Sears, until recently Northrop chief of aerodynamics; Irvin L. Ashkenas, now chief of aerodynamics; Warren Knieriem, project engineer; W. J. Cerny, director of engineering; A. M. Schwartz, chief of structures; and Carleton Bates, engineering and flight test coordinator.

It would have been impossible for Northrop's limited engineering staff to have completed the XB-35 project within the time allotted without the extensive help of both the Glenn L. Martin Co., and the Otis Elevator Co., who contributed the services of hundreds of technical experts and design engineers and many thousands of man hours to the project.

Although the XB 35 is by far the largest all wing airplane ever flown there are many indications that a worldwide race is already on to develop aircraft of all wing type with all possible dispatch. We now know that publication of information concerning the Northrop N1M all wing plane revived and greatly stimulated German interest in such types during the war years. Much of the German flying wing research has, of course, been made available to engineers of the U. S., Great Britain, and Russia, and it has been most helpful and encouraging. We know that the British are now going all-out for flying wing development and that American interest in the subject is now by no means confined to Northrop Aircraft, Inc. The next few years should bring a true revolution in the field of heavy aircraft design.



Newest Northrop flying wing — XB-35 — takes off from home field at Hawthorne with Max Stanley pilot Fred Charles Bretcher copilot and Orva H Douglas flight engineer as crew. Craft was reported to be unusually free of usual inevitable 'bugs'

Radical Vought XF5U-1 Opens New Flying Wing Vistas

SPECIAL FLYING WING SECTION

V-173 is one of man-carrying flying scale models company built of wood and fabric to test Zimmerman's low aspect ratio wing designs. Successful tests of these craft led to development of more powerful all-metal XF5U-1 soon to undergo Navy proving. Of particular interest is comparatively thick airfoil section used, also mounting of elevon control surfaces which have decided sweepback. Stabilizers are differentially controlled (International News photo)

Latest approach in all-wing philosophy is new 400-mph.-plus one-piece Navy fighter, stated to successfully utilize hitherto bypassed low aspect ratio configuration. Craft's outstanding feature is novel propeller arrangement permitting hovering.

STUDY of the new Vought XF5U-1 circular-type flying wing fighter reveals that this craft holds much promise in increasing the utility of high speed planes as regards top speed and low speed ratio—bringing into focus the possibility of further designs which may combine supersonic speeds with the ability to hover, or even land, in 'copter fashion

The XF5U-1's speed range is said to be 40 to 420 mph with standard power plants, 20 to 460 mph with water injection engines, and 0 to 550 with gas turbines installed A phenomenal rate of climb is also claimed

Most noteworthy characteristic is the craft's ability to hover on its props This is accomplished by standing the plane on its tail and changing blade pitch angle so that the props act as 'copter rotors. These specially articulated large diameter four-blade propellers have been designed and built by Chance Vought.

Power is supplied by two Pratt & Whitney R-2000 Twin Wasps of 1,350 hp each at 2,700 rpm. on takeoff Mounted within the wing on either side of the cockpit, they drive the props at the wingtips through right-angle transmission systems which incorporate a prop reduction gear ratio of 5:1 It's said that either engine can drive both props in event of emergency

Of all-metal construction, the XF5U-1 has control surfaces located at the trailing edges of the wing These include twin rudders and fins and elevon-type horizontal surfaces extending outboard Stabilizers can be differentially controlled to act as ailerons Conventional type retractable landing gear consists of dual main wheels folding backwards, and a fully swivelling tail wheel at the wing's extreme trailing edge

Pioneering research on the radical new design was done by Charles H Zimmerman, who first considered the idea of a circular wing configuration while head of the Stability and Control branch of NACA's Langley Memorial Aero Lab As theoretical aerodynamicist for the NACA, he was largely credited with design of the well-known LMAL Free Flight Tunnel and Free Spin Tunnel

In 1933 Zimmerman started his experiments on low-aspect-ratio wing designs, and the results indicated that whereas this planform had been sidetracked by engineers because of its theoretical inefficiency, the design actually was more efficient than conventional wings due to inherently greater lift and far lower drag

However, there was a decided loss of aerodynamic efficiency created by wingtip vortices which came about as a result of spilling of the air from the wing's under portion around the tips to the upper surfaces. Zimmerman then considered utilizing oppositely turning propellers at the wingtips turning counter to these vortices, thus preventing their formation and making possible an equivalent aerodynamic aspect ratio reaching 4, from a geometric aspect ratio of but 1. He patented this idea in 1936, and the next year rights were purchased by Vought. The company also hired him as consulting engineer to proceed with the project.

Since then a great deal of research has been accomplished using wind tunnel, small flying models, and full-scale man-carrying flying models The exceptional performance revealed by these led to construction of the all-metal high speed prototype which is expected to be tested by the Navy next month It's stated that work is proceeding on a gas turbine powered version in which the pilot will be prone

British Flying Wings Prepare Way for J-P Airliners

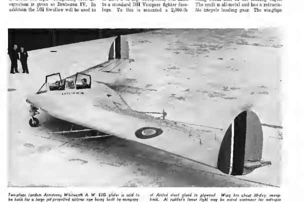
DH and Armstrong Whitworth are projecting large all-wing transports from data developed by testing small craft. Former company's test bed is Model 108 powered by Goblin turbine, while latter is Model 52G glider. Notable is use of sharply sweptback wings.

SUCCESSFUL DEVELOPMENT of the flying wing in this country appears to have started an overseas trend in this vein, as is evidenced by the appearance of the jet propelled DH 108 Swallow and the Armstrong Whitworth A W 52G glider Of particular interest is news that both craft are actually piloted scale flying models that are expected to supply data for the design of large all-wing jet-propelled airliners by their respective companies.

DH's Swallow has been built to provide information pursuant to development of the DH 106 transport, which is to be a transocean craft weighing about 75,000 lb and capable of cruising at about 550 mph Temporary civil designation is given as Brabazon IV. In addition the DH Swallow will be used to explore compressibility phenomena That the design is also being considered for its military applications is seen in the announcement that tests have included dogfights with a DH Mosquito fighter to measure the 108's maneuverability

In order to get the craft flying in the shortest possible time, the new wing, said to have a 43-deg sweepback, was fitted to a standard DH Vampire fighter fuselage To this is mounted a 2,000-lb thrust DH Goblin gas turbine with modified intakes situated in the leading edges of the wings on either side of the cockpit

Control surfaces consist of a sharply sweptback fin and rudder mounted above the engine nacelle, and elevon-type surfaces in the wings. Wing slots extend along about half of the leading edges. The craft is all-metal and has a retractable tricycle landing gear The wingtips



Two-place tandem Armstrong Whitworth A. W. 52G glider is said to be basis for a large jet propelled airliner now being built by company Glider is mostly of wooden construction with wing covering consisting of Alclad sheet glued to plywood Wing has about 30-deg sweepback. At rudder's lower right may be noted container for anti-spin parachute Landing gear is fixed tricycle (Charles E. Brown photo)

SPECIAL FLYING WING SECTION

are fitted with fixed skids also containers with anti-spin parachutes

Armstrong Whitworth A. W 52G

Although not much information is available on the larger airliner which is to be evolved from the A W 52G, it's stated that its general layout and control system will be very much like that of the test glider

The A W 52G is a two-seater mostly of wood construction, with covering being metal bonded to plywood The wing utilizes an NACA 65-3 2 20 section and has a sweepback at one quarter chord of 25 deg 38 min It contains 23 ribs on a single wood box spar having spruce webs Leading and trailing edges are made of solid spruce

Span is 53 ft 10 in, length 22 ft 10 in, height 10 ft 10 in, wing area 443 sq ft, and dihedral is 50 min 12 sec, taken at 41 chord Empty weight is given as 4,451 lb, crew 400 lb, ballast 1,150 lb, and gross weight 6,000 lb Top speed is said to be 250 mph, and stalling speed 55 mph

Of particular interest is the novel control system which incorporates specially designed horizontal controls that mainly deal with the craft's longitudinal stability, also to counteract down pitch caused by lowering of flaps or elevators These controls are Correctors hinged behind the spar, and two pressure-balanced elevons, called controllers The former are hydraulically operated, and the latter manually actuated.

The controllers have a balance plate attached extending ahead of the pivot point into a pressure chamber, which is divided into two sections by the balance plate. Three flexible rubberized fabric air seals are fixed between the balance plate's front edge and the front of the pressure chamber, and between upper and lower rear edges of the compartment and next to the control

Thus, by means of ports leading from the chamber's upper and lower sections, pressures acting on either side of the wing and on the control surfaces are duplicated on the corresponding side of the pressure chamber In this manner, pressure loads on the controller are balanced about its hinge points. Correctors are hinged on the upper portions and can move upwards only, to counteract nose downward pitching The correctors are controlled by a selector lever and are actuated by means of a hydraulic jack It's stated that in event of power system failure, manual actuation is sufficient to land the craft safely

DH's latest is 108 Swallow research plane which is to supply data useful in designing an all-wing airliner of about 75,000 lb Note slots fitted to leading edges of wings, which are swept back 43 deg Craft is to be modified later in order to study advantages of wing design as regards compressibility Power plant is DH Goblin II of 2 000-lb thrust (Central Press photo)

A rudder and fin assembly is fitted to each wing tip to simulate the requirements of a multi engine wing that might have to complete its flight with one or more dead engines. Landing gear is fixed tricycle and the nosewheel is not steerable.

During tests, the glider is towed up to about 12,000 ft, released, and the pilot guides it back to the airport. The flights are said to last about half an hour, and during this period, automatic test observations are made All instruments are grouped on two panels and photographically recorded by 16-mm movie cameras.

DESIGN DEVELOPMENT OF HORTEN FLYING WINGS

Eight types built, four projected by German brothers who tried variety of control systems and configurations in both gliders and powered craft, latter including twin-jet fighter-bomber and 60-passenger transoceanic transport.

As was the case with practically everything aeronautical the Germans were busy to the last on development of flying wings And as was the case with most of their projects, they didn't hesitate to try things radical—such as plastic ribs and wing covering

Among the outstanding German exponents of the flying wing were the brothers Horten—33-yr old Luftwaffe Major Walter, and 31 yr old Oberleutenant Riemar Perhaps one reason they were able to build eight and project four other types was Walter's political-mindedness which kept them in good standing with the Air Ministry, while Riemar contributed most of the engineering ideas.

The younger Horten's conviction that the wing was the most efficient aircraft far antedates the war, however, for the Horten I—a glider—was built in 1931 32, and was test flown about 7 hr Its span was 40 7 ft, area, 226 sq ft., gross wt. 440 lb, and empty wt, 264 lb It was a fabric covered wood craft, with one control surface on each side for both longitudinal and lateral control Directional control was achieved by flaps above and below the leading edge surface near the tips The craft was fairly successful, but didn't satisfy the Hortens, who burned it in 1934.

The Horten II was built during 1933 and 4—also at Bonn—and like the I was of wooden construction

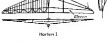
Two trailing edge surface controls were so linked that those outboard primarily gave lateral control and those inboard primarily longitudinal control Because of kinematics of the linkage, however, sidewise movement of the control stick gave slight displacement to the inboard surface, just as fore and aft stick movement slightly displaced the outboard surfaces.

During the first year it was flown as a glider, but in 1935 an 80-hp Hirth HM60R engine was installed, submerged in the wing and driving a pusher propeller through an extension shaft. Meanwhile three more of the type were built and flown as gliders

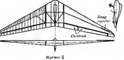
Nazi military leaders took more than a passing interest in the craft, for in 1938, at the request of the late Gen Ernst Udet, the well known Hanna Reitsch test-flew it rather thoroughly Though she found plenty wrong with it, such as "entry and exit—only possible for athletes" and "arrangement and operation of retractable undercarriage—only possible for long armed pilots," she did report that "the aeroplane cannot by any sort of control movements be made to drop the wing or to spin With the control column pulled right back the machine pitches lightly forward and sinks without reaching a speed of more than 40 kmh (This is a great help in flying through clouds if the instruments are iced up) "

In 1938 the Hortens built the III at Templehof, and the III-B was built for them by Peschke Flugzeugbau, also in Berlin This glider represented a growth in size—to 65 6-ft. span—and use of metal, for the center section was built up of welded tubes, while the outer wing panels were of wood.

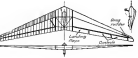
It represented a change in control sur-



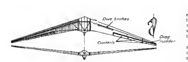
Horten I



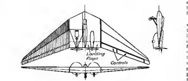
Horten II



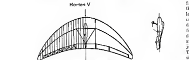
Horten III

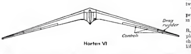


Horten IV



Horten V


Horten Parabola



Horten VI

faces, too, for three were put in the trailing edge of each side of the wing A little less than a third of the distance out from the center section was devoted to landing flaps, with the remainder out to the tips divided between surfaces used differentially as ailerons and elevators as on the II. Directional control was provided by tip flaps as in the predecessor types

Considerable experimental work was done with this type Dive flaps, for example, were tried out on both upper and lower center section surfaces, automatic flaps to limit diving speed were installed on the lower wing surface, the III-C had a small wing set forward of the main wing to give control down to low speeds; the III-D was built as a power glider, with propeller blades that could be folded to reduce drag during gliding

A new type directional control was also investigated In this the complete wingtip was hinged on a skew axis to rotate forward with decreasing incidence, backward with increasing incidence. It is reported to have been very unsatisfactory, causing the stick to thrash around in all directions so that the pilot couldn't hold it.

First of the series IV was completed in 1941, and incorporated further marked design changes Though it had the same span as the III (65.6 ft.) its aspect ratio was 21.16 against the III's 10.66, with a reversal of the wood-metal combination In the IV the center section was fabric-covered wood and outer wing panels were of metal, since this section was too thin for wood construction

The IV also incorporated an additional control change, one embodying three sets of surfaces in the trailing edge. Those outboard, operated by sidewise motion of the stick, were primarily for lateral control in the conventional manner However, they deflected slightly in response to a motion of the control stick in the fore and aft directions.

Both middle and inboard surfaces were operated by fore and aft stick motion, with the middle surfaces having a large upward deflection, but only a small downward deflection, the inboard surfaces having a large downward and a small upward deflection. Coupling between the control stick and surfaces was so arranged that the deflections for a given stick position increase or decrease progressively along the span Thus, on a wing being dropped, the outboard surface would have the greatest deflection, the middle a lesser, and the inboard the least, while on the wing going up the inboard surface would have the greatest deflection and the outboard the least A forward stick movement brought a sharp deflection of the inboard surfaces but only a slight deflection of the middle, just the opposite to an aft stick motion This variance in deflection made it possible to maintain wash out in the wing even though controls were displaced.

Another control change was that for directional control, for the brake-flap type was changed to a plate-type spoiler on both top and bottom surfaces between the front spar and aileron.

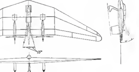
The transition to having the pilot in prone position was evident in the IV, for in it he was in a half-kneeling position

Another experiment tried was the IV-B, with a laminar flow wing made of plastic. This wing had very bad stalling characteristics, finally spinning in and killing the test pilot'

The Horten V series, of which the prototype was started in 1938, marked the transition from the high aspect ratio wing to the parabolic configuration, its aspect ration being 6.1 compared to 21.16 of the IV Designed from the start as a powered craft, it had two 60-hp. Hirth HM60R engines, turning in opposite directions, buried within the center section and driving pusher propellers via extension shafts Center section was built up of welded steel tubes and outer wing panels were wood.

In this series the Hortens reverted to their "conventional" control system—two moving surfaces on each side—together with landing flaps beneath the center section and spoilers at wing tips. Flaps were divided into three sections, that between the engines deflecting 60 deg, those outboard, 40

SPECIAL FLYING WING SECTION



Horten Proposed Glider Tug

Originally built as a two-place craft, the prototype was modified in 1941-2, to a single seater for extensive test flying at Gottingen the following year. A second craft of the type was built after the war started, this one having the cockpit faired completely into the wing, and with a retractable rather than fixed tricycle landing gear.

It was built almost entirely of plastic material, and had an improved version of the "waggle tips" first tried on the III Here again the result was failure—on the first test flight, made under high wind conditions, the craft bounced on landing, the pilot gave it full throttle, only one engine took hold and the plane crashed on a wingtip

The brothers Horten proposed, but never built, a glider tug based on the design of the V, their claim being that the point of tow cable attachment being near CG, the tug would be less susceptible to position of the glider

Next craft actually built was a glider whose plan form was that of two parabolas meeting at the wingtips. This craft was damaged in transit from the factory at Aegidienberg and was never flown before being burned

After the parabolic design the Hortens built the VI, a glider development of the IV having greater span but less dihedral Though its span was 13.1 ft greater than the IV, wing area of 191 sq ft was 12 less than the IV's and aspect ratio was 32.4 against the IV's 21.16 No information is available on its flight characteristics, but it is understood the craft did not handle well.

Number VII in the series put the Hortens back in powered craft, this time with one essentially similar to the V, but with larger engines—two 240-hp Argus AS10C's. Another change was rudder control, this one consisting of a wooden bar mounted on rollers behind and parallel to the main spar tip. Moving the rudder pedals simply moved one of the bars out of the tip to cause drag, but without blanketing the aileron Reports on it are directly conflicting, one calling it "very pleasant and satisfactory", another calling it "very unsatisfactory" Perhaps the latter is more nearly correct, since the device was not tried again as designs moved into higher speed ranges

The VII apparently was to be used as a tailless aircraft trainer. One had been completed by March 1945, the second was nearing completion at Minden, and 18 more were on order.

Under construction and scheduled for test flights about Nov 1945 was the Horten VIII, a transport designed to carry about 60 passengers on the trans-Atlantic run. Facilities at Gottingen limited its span to 158 ft, although original plans called for a larger craft. Powered by six 600-hp BMW engines turning pusher propellers, its cruising speed was estimated at 200 mph, and range about 4,500 mi

Even this large craft had wood outer wing panels—having one main and one auxiliary spar—and welded steel tubular center section. The control system was the familiar two-surface type used on the V.

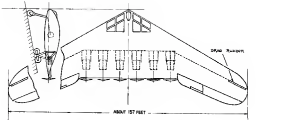
Marking the Horten's first venture into the jet propulsion field was the IX, a single-place fighter-bomber developed from the V and powered by two BMW-003 turbojets (See AVIATION for Jan, 1946 for Design Analysis of the powerplant) Production contract for the IX had been given the Gotha Co, and it is possible the Gotha P-60 (first described in Aviation for Oct, 1945) was developed from the Horten design

Sub-types of the IX ran from V-1 through V 4 Originally the design called for building the turbojets through the main spar, but on V-1's completion it was found that the jet engine diameter was greater than anticipated, so the

Specifications of Horten Flying Wings

Model	Span (ft.)	Area (Sq ft.)	Aspect Ratio	Gross Wt	Empty Wt	Wing Loading	Gliding Angle	Sinking Speed (fps)	No. Seats	Power	High Speed	Landing Gear	Construction
I	40.7	228	7.27	440	264	1.81	21	2.8	1			Skid	Wood
II	54.1		8.48	827	606	2.33	24	2.6		66 hp Hirth*		2 whl	Wood
III	65.6	403	10.66	770	550	1.91	28	2.13				2 whl	Wood-Metal
IV	65.6	203	21.66	660	440	3.5	37	1.77	1			2 skids	Wood Metal**
V	52.5	451	6.1	2,760	2,310	6.1			1–2	2–80 hp Hirth	134	Fx Tri	Wood-Metal
Glider Tug	Based on design of V											Fx Tri	Wood-Metal
Parabola	39.4	355	4.37	375	198	1.01	19	2.13				2 whl	
VI	78.7	181	32.4	770	550	4.01							Wood-Metal
VII	Based on design of V									2-240 hp Argus		Re Tri	Wood-Metal
VIII	158								60+	6-600 hp BMW	200+		Wood-Metal
IX	52.5			17,600		38–40			1–2	2-BMW-003	720	Re Tri	Wood-Metal
X	Based on III												
XI	26								1				
XII	Based on III								2	50 hp DKW			

* Installed after craft tested as glider ** Plastic wing tried



HORTEN VIII TRANSPORT

craft was modified as a glider for flight tests. (Since it was basically similar to the V no wind tunnel tests had been run) V 2 was then built to take the larger-diameter turbojets, V-3 was built by Gotha to study for quantity production problems, and V 4 was designed as a two place night fighter version.

The IX brought a third version of the wood-metal combination, this time having the center section of conventional welded steel tubular construction, outer panels of wood, but metal wingtips. The wing has one main spar — through which control rods are run—and an auxiliary spar. The plywood covering was given a special lacquer coating for smoothness. Since the turbojet exhaust came out on the upper surface of the wing, protective metal plates were installed over the wood skin in the affected area.

The two moving surface control system which had earlier proved satisfactory was again used on the IX, with two changes: the control stick could be lifted up a few inches to increase pilot's leverage for high-speed operation.

For lateral control the craft had two sets of spoilers, the smaller of which came out of top and bottom wing surfaces first, followed by the larger pair to give smoother action at high speeds.

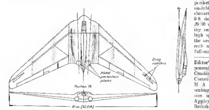
Though complete figures are not available, the craft was said to have a top speed of about 720 mph at 210.000 ft, with a range of about 1,650 mi. With full fuel load and complete armament consisting of four 35 mm cannon and 4,400 lb of bombs, gross weight ran to 17,600 lb.—giving wing loading of 38,-40 lb per sq ft. Takeoff runs of 1,600 ft. under light load were obtained in early test flights, and runs of 3.000 ft were predicted for takeoffs when fully loaded.

Early in 1945 the Horten's either believed Germany was going to win the war or were getting all the research they could with Luftwaffe money, for they had under way the X, said to be a version of the III but with movable wing tips for directional control.

The XI, which was also under construction at Hersfeld, was a 26 ft. span single place glider designed for full acrobatics.

End of the Horten development string was the XII, reported to have reached the flight test stage. Basically similar to the III, it was a two-place side-by side personal plane powered by a 50 hp DKW or Hirth engine.

Throughout their careers, the Hortens avoided the use of vertical fins for directional control and stability, disagreeing heartily—and, it appears correctly—with the famed Dr Lippisch who had predicted that Horten craft would be unstable without vertical fins. A common characteristic of all Horten wings was a 6-8 deg washout and sweepback of 20-30 deg. They were, however, working on greater sweepback later on as high speed jet propelled craft became the order of the day. This work was with models and had not reached the full-scale test stage at war's end.



Editor's Note. Much of the material presented in this article is based on a Combined Intelligence Objectives Sub-Committee report prepared by Lt. Cmdr M. A. Biot, USNR, team leader representing the U. S. Naval Technical Mission in Europe, and Flt. Lt. D. C. Appleyard, RAFVR, representing the British Ministry of Aircraft Production.

Supersonic Flight Poses Many Design Hurdles

Too great a number of basic problems concerning ultra-speed flight have not yet even been explored—let alone solved—to permit hasty thinking by laymen or tyro engineers that the supersonic age is "just around the corner". Here a skilled aerodynamicist cautions against leaping to formula conclusions and explains some of the manifold barriers facing the country's top designers in plotting craft for faster-than-sound human flight.

NUMEROUS aviation enthusiasts are inclined toward the conviction that this year's applied research with experimental sonic and supersonic aircraft portends a matter of fact transition to airliners and fighters with speeds of unlimited miles per hour. And often such convictions are stubbornly intensified in the face of formula-burdened explanations of ultra-high speed flight problems. A far more realistic viewpoint is held by aerodynamicists—that such products of the supersonic imagination are little more than specks upon the horizon of the often loosely pictured "foreseeable future".

A simplified, almost casual hint of a few of the problems of supersonic design is presented by E. H. Heinemann, chief engineer, Douglas Aircraft Co., who is at present closely connected with the company's high speed flight experiments.

"Nothing can be considered aerodynamically impossible", Mr. Heinemann states, "but since 1903, the average speed increase of human flight has only been about 14 mph./yr., including spurts after each war when research expenditures were large. Never at any time has the level flight of any stripped-down airplane exceeded this rate of advancement. This applies only to speed record flights and not to normal operations, and it is well to note that regular aircraft operating normally usually fly about half as fast as the pace setters."

His accompanying chart (Fig. 1) shows how closely world aircraft speed records, up to and including the British Meteor jet flight record, follow this trend of speed development.

"We must understand", Mr. Heinemann continues, "that it's no longer possible for someone to tinker around in a backyard and come up with a 100 mph speed increase. Vast engineering and production groups composed of technical specialists, even whole sciences, are responsible for the creation of a new airplane. Achievements today are measured in terms of research expenditures. War appropriations will be evident in increased speeds for the next few years, later extra miles per hour will depend upon the amount of time—and time means dollars—that will be allotted to research."

He believes that while available power is rapidly increasing, the problems involved in shaping wings and airframe structures to meet new aerodynamic demands will preclude revolutionary varia-

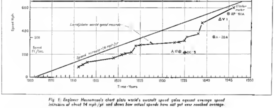


Fig. 1. Engineer Heinemann's chart plots world's aircraft speed gains against average speed increases of about 14 mph./yr. and shows how actual speeds have not yet ever reached average.

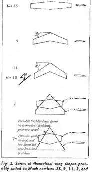


Fig 2. Series of theoretical wing shapes probably suited to Mach numbers .85, 9, 1.1, 2, and 2 plus.

tion from an orderly development in increasing the speeds of human flight

His sketches (Fig. 2) of presently conceived wing plan-forms suited to conditions approaching and surpassing the speed of sound contain a hint of the selection problems confronting designers

These sketches depict a variety of idealized shapes that would probably be best suited to speeds of the order of Mach .85, .9, 1.1, 2, and 2-plus, a speed range of from 646 mph to 1,500 mph and beyond.

And, ultimately, supersonic aircraft engineers will find themselves committed to a program of extended research in determining how to compromise shapes that will be as varied in performance as in contours.

The latter observation is pointed up in Heinemann's suggestion of alternate plan forms for speeds of Mach 2 and 2-plus. One, triangular, offers probable good high speed performance and minor transitional problems but probably would perform poorly at low speeds. The other holds promises of good high and low speed performance, but might present serious transitional problems.

In three drawings of airfoil shapes (Figs. 3, 4, 5) the Douglas engineer depicts the hurdles facing designers struggling to compromise airflow characteristics which change abruptly and vigorously as aircraft speeds advance

Fig 3 shows airflow over a typical airfoil to be well-behaved at a flight speed of 500 mph (Mach .65). However, at 700 mph (Mach .916), airflow over portions of the wing surface may possibly reach speeds of 1,000 mph and then drop abruptly (behind resultant shock waves) to 730 mph, as indicated in Fig. 4. Finally, as depicted in Fig. 5, the airfoil flown at 1,500 mph may have wing surface airflows ranging from 1,275 mph to 1,690 mph

With this information, and the admission that there exists a lack of data concerning behavior of wings in the supersonic speed ranges, Heinemann prompts a realistic view of the time factor required before the barrier is overcome

"I don't want to say", he sums up, "that many of the predictions about supersonic flight aren't possible. I would like to go on record with the viewpoint of the engineer—one of those with whom lies the responsibility of translating ideas into facts. While recent scientific developments have indicated that future speeds are practically unlimited, any great advancement in speed over the orderly trend will only come as a result of a vast amount of time-and money consuming research development and engineering

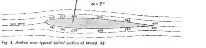


Fig 3. Airflow over typical airfoil section at Mach .65

Fig 4. Airflow over same airfoil at Mach .916

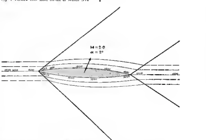


Fig 5. Wing surface flows over typical airfoil at Mach 2.

SIMPLIFYING PERSONAL PLANE DESIGN

PART II

Here, for the "general practitioner," is an easily workable method of power estimation — together with handy formulas for the engineering department where time- and money-budgets don't include specialists.

By RALPH H. UPSON, *Consulting Engineer*

In this first article of this series[1], we considered quite properly the medium through which the aircraft must be propelled and by which it is supported. But even more important, for aircraft or anything else, is what the vehicle can do—in other words, performance. Taken broadly, that one subject covers a preponderent part of airplane design. But in this and a subsequent article we shall be satisfied to deal with the conventional or 'classical' items of performance largely dependent on power.

First a distinction must be made between performance attainable with a given airplane, or given airplane design (which amounts to the same thing), and performance set down as a prerequisite or objective of the design itself. Here also the present article must be limited by dealing with the first of these aspects only. The second, calling for a somewhat different approach, must be reserved for a later issue.

But what is the need for any new article on performance? As if there hadn't been enough reports, papers, articles and even books on the subject already! In fact, there have been too many. Variously advocated have been generalized equations, nomographs, logarithmic plotting, transparent forms and stencils, special slide rules, and what not.

Nearly all of these methods have some merit—for anyone wishing to make such work a life-time specialty. But for the average aircraft engineer—the 'general practitioner' who has plenty of other things to do—the task of learning a special system of almost any kind is likely to be more trouble than it is worth. If he were to take each such performance system seriously enough to give it a fair trial (not to mention special methods of analysis that have been developed for countless other purposes), an 'X-ray' of his mental equipment, mostly unused, would bear a close resemblance to Fibber McGee's hall closet.

The general advantages of algebraic formulas, simplified in most cases by empirical methods, have been brought out in Part I. Such methods are not only adaptable but particularly useful in performance analysis. Even in straightforward computation of a given design, simple formulas are hard to beat for getting results with minimum effort, but they are still more appropriate to the creative stage of a design where alternatives must be tried and the benefits and penalties of various modifications appraised. Simple formulas, moreover, may be readily translated into almost any other method desired

For the fundamental basis of performance there is no need to go beyond time honored 'power required' and 'power-available' concepts—the classical approach, so called no doubt because its origin seems lost in the mists of aeronautical antiquity, over forty years ago. In plain language, the power, on which performance depends reduces simply to consideration of (1) What do you need?, and (2) what have you got?

Power Required

As usual, power required is taken to mean the thrust horsepower required to overcome the drag in level flight at a given constant speed and air density. Quantitatively,

$$thp_r = Dv/375 \qquad (2\ 1)$$

where D is the total drag without propeller or slipstream. Divided into the usual profile-parasite and 'induced' terms,

$$D = fq + W^2/(\pi e b^2 q) \qquad (2\ 2)$$

where b, q, and W represent the usual span, dynamic pressure, and gross weight, respectively; the drag area f and the effective span factor e being defined in any modern aerodynamic text. It should be understood that, by conventional definition here employed, the second term of the above equation includes, besides the true induced drag, an approximation of all drag, for a given airplane, that cannot be fitted to the condition of constant f assumed in the first term. The corresponding 'fudge factor' e, when first proposed[2], was called by the rather misleading name "airplane efficiency factor". This factor is nevertheless a very useful one if its true purpose and limitations are realized

Apparently the term 'efficiency' was first used because of a supposition that e could be taken as a measure of how closely the wing downwash approached an ideal constant value along the span. But it is now well recognized that the extent to which e falls short of unity, in a well designed airplane, is largely due not to induced drag at all, but to that part of the profile drag which varies in similar manner to the induced drag, except for being independent of span b. Thus the value of e (applied as a factor to b^2) is substantially reduced as the span is increased. This does not mean that an airplane of large span or aspect ratio is any less efficient, it means only that an appreciable part of what for convenience has been treated as induced drag is really not induced and must therefore be adjusted to the realities of the situation

For conditions making the induced drag small, such as at maximum speed,

[1] Part I Page 55 June Aviation

[2] W. Bailey Oswald, NACA TR 408

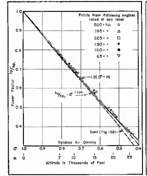


Fig 1

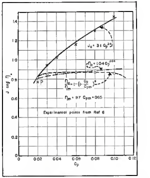


Fig 2

e can be simply assumed at an average value of 0.85; for other conditions it can be closely approximated by the formula here given. We hope to discuss more fully (in a later article) the general case where e, f and η must all be evaluated by computation, wind tunnel, or flight tests, including the interesting effect of thrust where part of the induced drag is most conveniently handled in the profile-parasite term. Sample numerical values of f and η will be found in our first AVIATION series, Designing Tomorrow's Personal Plane".[3]

The fundamental power-required equation (13), is obtained by simply substituting (2.2) in (2.1). It has often been proposed to simplify this equation further by multiplying through by $\sqrt{\sigma}$ (Ref. 4), thus getting it in terms of the indicated airspeed (defined in Part I) and the so-called 'indicated power', the purpose being to permit drawing a single curve good for any altitude. For the analytical methods here used, however, this advantage is of little consequence especially considering that analysis for only two altitudes, sea level and 7,000 ft[4], is sufficient for most purposes, but the real trouble with the single power-required equation is that it complicates nearly all the attendant relations, including power available. Hence we return to consideration of the actual power and speed.

Power Available

All engines here considered are tentatively assumed unsupercharged, developing full rated brake horsepower (hp_o) at sea level, at full throttle, and at the rated rpm (1,000N). In the standard atmosphere, the actual brake horsepower (hp) may then be reduced in any one of three ways: (1) By increase of altitude, (2) by decrease of rpm at full throttle, and (3) by throttling. The thrust horsepower finally available is then, of course

$$thp_o = \eta hp = Tv/375 \qquad (2.3)$$

analogous to (2.1), where η is the propulsive efficiency and T is the effective thrust obtained by subtracting from the total thrust any increase of drag due to the slipstream.

The efficiency η depends on the many parameters entering into the design of the propeller itself, on parts subject to drag in the slipstream and on the altitude, speed, and other conditions of use. The infinite combinations and variations in these conditions can best be approached through the principle of geometric and aerodynamic similarity obtained by use of the proper ratios and coefficients, in particular the 'advance ratio' J and the power coefficient C_p, defined in the list of symbols. In respect to all major operations in the development of the performance equations, sufficiently general form will be maintained, so that any desired propeller of known characteristics can be employed.

To take account of second-order effects in the simplifications of the working formulas, and to provide an example for quantitative solution, a specific propeller design (to be referred to as the 'representative propeller') will be used. This propeller is two bladed, of blade planform corresponding to Navy No. 5868-9[5] (Clark Y section). Although the propeller from which the test data are taken was of metal, the planform and section (8% tip thickness) are conservative enough to be usable, with slight modification, in a modern wood construction. This particular blade has an activity factor[6] of about 80, for present purposes assumed to be the minimum feasible for wood; but, as a lower value is indicated by aerodynamic considerations in nearly all cases, the blade chosen appears satisfactorily representative, especially with the actual maximum efficiency and other characteristics left open and subject to revision.

From studies of takeoff (to be brought out in a later article) it appears that with any modern direct-drive engine it is worthwhile to use the largest propeller that will limit the tip speed to a desirable maximum, making a reasonable choice of representative conditions—$N_s \times dia$ = 17 for metal, or 15 for a wood propeller. With a 2% allowance for the contribution of the axial speed component, this relation is equivalent to a tip Mach number of about 0.81 for metal or 0.715 for wood—conservative values[7] which allow a little margin for noise reduction, moderate altitude, and cold weather. With wood, the critical M/V is thus a little lower, though it need not be as much reduced as with designs of 10 yr ago (Ref. 5). Since a wood propeller will commonly be the fixed-pitch type turning at less than maximum rpm both for takeoff and climb, and ordinarily throttled for other conditions, it will often be found possible to increase the $N_s \times dia$ product above indicated. Improved tip planform and section will also permit some increase for either wood or metal. The importance of noise reduction imposes an opposite trend (plus an increased number of blades), but usually at too much sacrifice of low-speed thrust unless N_s is reduced by gearing.

In any case, favoring takeoff (over a 50 ft obstacle) is particularly important with the modern tendency toward higher wing loadings, and the corresponding penalty on airplane top speed is in most cases negligible. Expressions alternative to the more general type are given to fit this condition of limiting tip speed, applied to the representative propeller, for direct drive only.

Variable Pitch

In most treatments of performance, the fixed-pitch propeller has been considered first, probably because of its historical priority and mechanical simplicity. Analytically, however, the variable-pitch type, of constant rpm, is not only simpler, but is basic to a consistent treatment of fixed-pitch and other types.

The assumption of constant rpm with full throttle, for a given set of atmospheric conditions, establishes constant brake horsepower and constant power coefficient C_p. Although there appear rational grounds for allowing slightly more rpm with increasing altitude (where torque, power, and compression are all reduced) present standard practice will be followed of using the same full throttle rpm at all altitudes. Under these conditions, thermodynamic justification is claimed for the belief that the engine power varies almost directly with atmospheric pressure and substantially independent of temperature (Ref. 5). At any rate, in the standard atmosphere, the function

$$hp/hp_o,\ p/p_o = \sigma^{1.235} \qquad (2.4)$$

seems to give a close but conservative measure of the altitude power factor, as shown by results from 6 different engines varying from 65 to 225 hp in Fig 1. The corresponding variation in C_p is small, being represented by the factor

$$C_p/C_{p1} = \sigma^{1.235}/\sigma = \sigma^{0.235} \qquad (2.5)$$

If the propulsive efficiency η at constant rpm is plotted against J, for a given C_p, the curve is found to bear a geometric similarity to those for all other C_p values, so that to a close enough order of approximation η/η_m is the same function of v/v_m for all cases. This principle is already well recognized[8] but its use often has been confused by failure to distinguish v_m, the speed of maximum efficiency η_m, from v_m the maximum speed.

Another frequently neglected factor, although not an important one, is the change in maximum efficiency (and the speed at which it occurs) with altitude. For this purpose an expression for efficiency ratio as a function of C_p/C_{p1} is needed. For the representative propeller (Fig. 2) within the range $.02 < C_p < .08$, an empirical approximation, applied to (2.5), gives

$$\eta_m/\eta_{m1} = (C_p/C_{p1})^{.064} = \sigma^{.015} \qquad (2.6)$$

and

$$v_m/v_{m1} = J_m/J_{m1} = (C_p/C_{p1})^{.34} = \sigma^{0.08} \qquad (2.7)$$

where the subscript m throughout indicates the value or condition at maximum thp and efficiency, and subscript 1 indicates the sea level value. An alternative equation plotted in Fig 2 gives a more accurate representation of peak efficiency, but (2.6) is believed close enough to cover the minor effects of altitude.

Fig 3 shows a collection of points representing the efficiency ratio as affected by variation of speed v at any given altitude. The formula fitting closest to the average, for the full range of practical conditions, is the one presented as (17) for sea level conditions. Similarly, for any given altitude

$$thp_o/thp_{om} = \eta/\eta_m = 1-(1-v/v_m)^{8/3} \qquad (2.8)$$

Substitution of values from (2.4) to (2.8) in (2.2) with further empirical simplification, now permits expressing

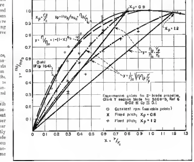


Fig 3

[3] Particularly Part II, July, Part V Oct. Part VI, Nov '45, and Part VIII Mar, '46, AVIATION

[4] The range covered by present CAA requirements (CAR 03)

[5] TR 640 Ref 6

[6] W C Nelson, *Airplane Propeller Principles*

[7] NACA TR 639

[8] Diehl Ref 3 Part 1

the power available, Eq (14), as a simple function of speed, altitude (expressed by relative air density), and sea-level thrust horsepower $\eta_1 hp_1$ (at any given speed v) for the entire range of possible conditions

Fixed Pitch

We have thus far considered a propeller automatically (or otherwise) varying in pitch in such a manner that it maintains the same rated rpm at any airplane speed or altitude Suppose that for any combination of such conditions the blades are frozen in angular position. The propeller then becomes a fixed pitch type If we focus attention first on a particular altitude, such as sea-level, for operation at varying speed, this 'freezing point' v_p can be either above, below or at the speed v_o of maximum efficiency η_o. Expressed in ratios, as in Fig 3, the coordinates of this point are thp_p/thp_o ($= \eta_p/\eta_o$), and v_p/v_o. Though most commonly chosen to approximate maximum speed, the speed v_p has no necessary or direct relationship to maximum speed or any other characteristics of the airplane, but represents simply one point on the thp_a curve that is identical with the variable-pitch type The only other point common to both curves is, of course, the origin where thp and v are both zero in each case.

Considerations of geometric and aerodynamic similarity show that the actual thp curve for a fixed pitch propeller must be between the variable-pitch curve and a straight line joining the origin to the 'freezing point' In other words, the thrust horsepower relative to its rated value thp_a ($= \eta_p hp_a$), at any speed v, must be between the value given by Eq (2.8) and the straight line function $(v/v)(\eta_p/\eta_o)$ Practical trial shows that a simple geometric mean is a good representation of the actual points for an engine whose power varies linearly with rpm* ($PDF = 0.8$), as indicated in Fig 3 for $v_p/v_o = 0.8$ and 1.2, the points covering a substantial range of C_{po}. Thus the sea level thrust horsepower

$$thp_{a1} = hp_1 \sqrt{\eta_1 \eta_{p1}\, v/v_{p1}} \qquad (2.9)$$

Conditions at altitude geometrically similar to those at sea-level will be obtained at the same speed and rpm. with torque and power reduced in proportion to σ But as already noted for the variable-pitch propeller, the full-throttle power actually varies as $\sigma^{1.235}$ for constant rpm

For an average value of $PDF = 0.8$, the torque Q is independent of rpm and varies only with altitude.

*Diehl Ref 2, Part 1

THIS MONTH'S FORMULAS

Power Required (level flight)

$$(13)\ thp_r = \frac{f\sigma v^3}{146{,}600} + \frac{0.332\ W^2}{e\, b^2 \sigma v}$$

$$= \frac{f v^3}{181{,}000} + \frac{0.41 W^2}{e\, b^2 v}$$

for $\sigma = .811$ (7000 ft)

Ref text, Eq (2.1) & (2.2) also Ref. 4

Power Available [Constant rpm (variable pitch)]

$$(14)\ thp_a = \sigma^{.835\,(14+v/v_{01})} = \sigma^{1.17}\eta_1 hp_1 \left[1 - 0.1\,(v/v_{01})\,(1-\sigma)\right]$$

$$= .782\ \eta_1 hp_1\,(1 - .02v/v_{01}) \text{ for } 7{,}000 \text{ ft}$$

within about 1% for conventional propellers operating at tip $MN < .810$ for metal or $MN < .715$ for wood and $.02 < C_p < .10$

Ref text Eq (2.3) to (2.8), also Ref 5 and 6

Power Available — Fixed Pitch ($PDF \simeq 0.8$)

$$(15)\ thp_a = \sigma^{1.2} hp_1 \sqrt{\eta_1 \eta_{p1} v/v_{p1}}$$

$$= .762 hp_1 \sqrt{\eta_1 \eta_{p1} v/v_{p1}} \text{ for } 7{,}000 \text{ ft}$$

where η_1 and η_{p1} are both on curve for constant C_{p1} at rpm of 1.000 N_a

Representative Propeller in the installed range (Navy No 5868–9, 2 blades Ref 6)

$$(16)\quad dia = 17/N_a; \text{ for metal}$$
$$\text{or}\quad 15/N_a, \text{ for wood}$$

suitable for tentative choice of diameter in most cases of direct drive where $N_a hp^{1/4}$ lies between 8 and 10 hp from 50 to 250

$$(17)\ \eta_1 = \eta_{01}\left[1 - (1 - v/v_{01})^{5/3}\right]$$

average values of points shown in Fig 3

$$(18)\ \eta_{p1} = \eta_{01}\left[1 - (1 - v_{p1}/v_{01})^{5/3}\right]$$

$$(19)\ \eta_{01} = \bar{\eta}_{01}\,(1 - 4f_f/\pi\, dia^2)$$

$$(20)\ v_{01} = 11.36 J_{01} N_a\, dia = 34 C_{p1}^{1/3} N_a\, dia = 19 N_a^{2/3}\, hp_1^{1/3}$$

for $dia = 17/N_a = 20.6 N_a^{2/3}\, hp_1^{1/3}$ for $dia = 15/N_a$

Equations (18) to (20) are within about 5% for the given propeller design operating at $.02 < C_p < .10$

$$(21)\ \eta_{01} = .87\left[1 - (1 - 15C_{p1})^3\right]$$

within 2% for the given propeller

$$(22)\ C_{p1} = N_a^3 hp/28{,}400 \text{ for } dia = 17/N_a$$
$$\text{or } N_a^3 hp/15{,}200 \text{ for } dia = 15/N_a$$

accurate for the conditions stated

Alternative to powers of σ

$$(23)\ \sigma^n \simeq 1 - \frac{1.4\, n}{1 + 0.4\, n}(1 - \sigma)$$

within 1% for positive values of n up to 1.3 at $\sigma = 0.5$

Thus if $v \propto N$

$$Q/Q_1 = \sigma^{1.235} = \sigma N^2/N_1^2 \qquad (2.10)$$

from which

$$N/N_1 = \sigma^{.117} \qquad (2.11)$$

and

$$thp_a/hp_{a1} = QN/Q_1N_1 = \sigma^{1.352} \qquad (2.12)$$

when speed is reduced in the same proportion as N in (2.11) If, on the other hand, speed is to be held constant, Eq (2.9) shows that thp_a in (2.12) will be altered in approximate proportion to v, making

$$thp_a/thp_{a1} = \sigma^{1.352}/\sigma^{.117} \simeq \sigma^{1.2} \qquad (2.13)$$

Substituting thp_{a1} from (2.9) now gives Eq 15 for power available with fixed pitch at any speed and altitude in terms of the variable-pitch propeller, the only additional data required being the speed v_{p1} at which the propeller develops its rated power and its efficiency η_{p1} at that speed (at sea level).

Because of the slowing down of a fixed-pitch propeller with reduced airplane speed, the shape of the full-throttle engine hp vs rpm curve is also

SYMBOLS

a = true airspeed, any altitude (mph.)
v_m = maximum speed at given altitude
v_o = speed of maximum η for given C_p (constant rpm)
v_p = speed at which a fixed pitch propeller attains its rated rpm
hp = brake horsepower at rated rpm , any altitude, full throttle
= $\sigma^{1.235} hp_1$
thp_r = thrust horsepower required
thp_a = thrust horsepower available from propeller
= ηhp at constant rpm.
η = propulsive efficiency at any speed and altitude at constant rpm
η_o = maximum propulsive efficiency for given C_p (constant rpm)
$\bar{\eta}_o$ = same uncorrected for slipstream drag
η_m = maximum ordinate at curve of η_o vs C_p
η_p = propulsive efficiency at speed v_p
Subscript 1 on any of the above signifies sea-level value at same speed v
N = propeller rpm /1,000
N_a = rated value of N
C_p = $50hp/\sigma N^3 dia^5$ = power coefficient
C_{p1} = $50hp_1/N_a^3 dia^5$ = rated sea-level power coefficient
C_{pm} = value of C_p at which $\eta_o = \eta_m$
J = $.088v/(N\,dia)$ = advance ratio
J_o = value of J for $a = v_o$ and $N = N_a$
f = effective drag area, total (= airplane $C_{DP}S$) Ref. 4

For typical values, Part II of our first series, "Designing Tomorrow's Personal Plane" (page 145, July, 1945, Aviation)

f_f = effective drag area in slip stream (fuselage, tail and wing root)
σ = air density/standard sealevel density (see previous article, June '46)
W = gross weight (lb)
b = span (ft)
$1/e$ = Oswald factor $\simeq 1/e_1 + .01AR\,(\lambda - 0.4) + 2ARC_{Dpo}$
$1/e_1$ = interference factor <1.02 for good design
AR = aspect ratio = b^2/S
λ = taper = chord/root (¢) chord
C_{Dpo} = minimum wing profile drag
PDF = Diehl's power drop factor (Ref 2)
dia = propeller diameter (ft)

References

(Continued from Part 1, page 59, June Aviation)

4. Clark Millikan, *Aerodynamics of the Airplane*, 1941
5. E P Warner, *Performance*, McGraw-Hill Book Co., 1936
6. Hartman and Biermann, *Aerodynamic Characteristics of Full-Scale Propellers Having 2, 3, and 4 Blades of Clark Y and RAF 6 Airfoil Sections* NACA TR 640

a factor in the thrust horsepower developed Data for present available engines, however, show nearly all to have $PDF = 0.8 \pm .02$, which means hp. substantially proportional to rpm over the entire range used for flight performance, as here assumed Here in the normal flight range the rpm of the fixed-pitch propeller is reduced approximately in proportion to thp_a from Eq (15) as compared to (14) If the brake horse power departs appreciably from the assumed straight-line variation, the thp_a will be altered in about the same proportion at any value of the rpm. as above established.

Maximum Propeller Efficiency

Eqs (14) and (15) are each in terms of the actual sea level efficiency η_1 for a propeller at any given airplane speed v and at the rated rpm (the latter being a fictitious condition for a fixed pitch propeller except at the one speed v_{p1}) Thus, except for secondary effects, particularly applying to (15), the equations are in general form, and permit using any actual or desired shape of the efficiency curve vs. speed. For the representative propeller, Eqs (17) and (18) give η_1 and η_{p1} as conservative averages for the C_p range noted in Fig 3 Other propellers give points within a similar range of values. The only remaining unknowns are η_{01} and v_{01}.

As shown in Fig 2, the peak efficiency η_o (on curve of η vs J) is in turn a point on the curve of η_o vs C_p having a maximum η_m at C_{pm} As most of the usable range for light planes is at $C_p < C_{pm}$, a simple power function appears as a satisfactory means of dealing with the unimportant altitude effect, as already indicated The more general expression, in terms of the ratio C_p/C_{pm} although given in the formulas for the representative propeller, is apparently a good approximation for nearly any type of propeller if the C_{pm} point is picked with good judgment. In many cases η_o = constant can be assumed over a considerable range of C_p.

In the application of propeller test data to practical conditions, one of the most important considerations is power loss due to added drag in the slipstream which, by accepted definitions of propulsive efficiency, is put in the same class as power loss in the propeller itself. Neglecting second order effects, the slipstream velocity which produces this drag increment is same as what accounts for the thrust itself Thus a balance of momentum shows that the drag increment bears the same ratio to the thrust as the effective drag area f_f in the slipstream bears to the propeller disc area This means that almost regardless of speed, altitude, or type of propeller, the thrust, thrust power, and efficiency at a given speed are all subject to a reduction factor

$$K_s = 1 - 4f_f/\pi\, dia^2 \qquad (2.14)$$

This expression naturally does not cover effects due to a change in the type of flow induced by the slipstream (such as discouraging local separation over the root of a low wing) It assumes that the full final slip velocity is developed over the parts represented by f_f, but neglects changes in speed of a purely hydrodynamic nature around the fuselage The latter is often important in the choice of blade angle distribution, but is apparently of negligible effect on efficiency if the blade angles are correct

From the description in Ref 6 of the propeller test rig, it is estimated that the nacelle and portions of the struts in the slipstream had a drag area of $f_f = 2.1$ sq ft. A diameter of 10 ft. for the propellers tested made $\frac{\pi}{4} dia^2 = 78.5$, giving a test $K_s = 1 - 2.1/78.5 = .973$. Strictly speaking, the use of these test data in the thrust formulas here given would be predicated on initial division of the tested efficiencies by .973 but this additional 2.7% margin is here retained in the case of the representative propeller, as allowance for other small losses commonly to be expected

The slipstream drag area f_f is normally made up by the fuselage, wing roots, and tail surfaces. For a well designed plane with side-by-side seating, it should not be more than 2.5 to 3 sq ft., but with struts landing gear members, and poor windshield it will readily run more.

Application of Formulas

Although applications to specific items of performance will be taken up in the succeeding article, it is apparent that most problems can be handled by direct use of the power required and available equations. If the engine is supercharged to develop its rated hp at a given critical altitude, it can be given a fictitious

(Turn to page 142)

PRACTICAL ENGINEERING
OF ROTARY WING AIRCRAFT

PART II

By **PAUL H. STANLEY,** *Chief Engineer, Autogiro Company of America*

Continuing his comprehensive discussion of rotorcraft design problems, Engineer Stanley presents two further analyses—first, a study of the appplication of jet-drive to blades of a direct control autogiro; second, an examination of loads developed in blades of a jet-driven 'copter or in autogiro blades with jet-assisted takeoff and landing features.

Pending achievement of those factors necessary to make the completely jet-driven helicopter feasible—reduction of weight and size of jet units and improvement in fuel consumption—it is considered that an important intermediate step would be the application of rocket-propulsion-type driving units to blade tips of a direct control autogiro. An installation of this nature would make it practical for the autogiro to make helicopter takeoffs and landings, and also permit two or three brief periods of helicopter operation during flight Under combined action of the rocket driven rotor and full engine power, rate of climb would be more than twice that of either autogiro or engine driven helicopter for the same engine power weight ratio. Also, for brief periods, the combined autogiro helicopter would be capable of substantially greater maximum speed than either the autogiro or engine-driven 'copter.

An autogiro, whose performance has previously been calculated, will be used to show the potentialities of this combination (Weight analyses made on two existing autogiros have shown that the present rotor starter and pitch change mechanism can be replaced with jet-driving units, necessary tubing, fuel containers, fuel for one minute with no increase in weight) Since the autogiro (2,100 lb gross wt, 40.25 ft rotor dia.) originally considered used a solidity of .06, this value will be retained From other calculations, it is found that optimum performance at zero forward speed, for a jet driven rotor of this solidity, is at a rotor peripheral tip speed of 585 ft./sec With a jet force of 88 lb per blade, rate of climb is shown to be 1,580 ft./min As in the assisted takeoff autogiro, greater percentage of flight operation will be as an autogiro, the jet size will be reduced to give a rate of climb at zero forward speed of some 300 ft./min Excess rate of climb (calculation not shown) is, therefore, $1{,}580 - 300 = 1{,}280$ ft./min., corresponding to an excess hp of $1{,}280 \times 2{,}100 / 33{,}000 = 81.4$.

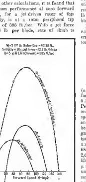


Fig 1 Sea-level performance of autogiro with jet assisted takeoff

Hp input to rotor of completely jet-driven 'copter, at 585 ft./sec is $191 \times (585 / 400) = 279.4$

Hp required for assisted takeoff of autogiro is then $279.4 - 81.4 = 198$, with a corresponding jet force per blade required of $88 \times (198 / 279.4) = 62.5$ lb., giving a unit of 2.5 lb weight per blade.

For operation at 585 ft./sec tip speed, with 62.5 lb jet force per blade (delivering 198 hp to rotor), thrust and torque coefficients are:

$$\frac{2{,}100}{.00238 \times .06 \times 20.125^2 \times \pi \times 585^2} = .0340$$

$$\frac{198 \times 550}{.00238 \times .06 \times 20.125^3 \times \pi \times 585^3} = .0030$$

Checking for performance at $\mu = 0$ (as a helicopter only), rate of climb is found to be 414 ft./min., blade pitch 5.25 deg., and mean profile drag .0145 Performance as a jet-driven helicopter only is calculated, and is shown as a speed polar in Fig. 1 Performance as an autogiro, using a propeller giving best high speed, is also shown in this graph Finally, the performance potential of the combination is shown, giving a rate of climb, at zero forward speed, of 685 ft./min., maximum rate of climb of 2,680 ft./min., and maximum speed of 158.8 mph (Note Rate of climb at $\mu = 0$ is greater with engine-propeller unit operating than as pure helicopter, since, to get zero forward speed, craft will be at a high angle, and thus propeller carries part of gross weight, and actual rotor thrust required is reduced.)

Weight of fuel required for one minute of full power operation at .0055 lb./sec./lb thrust is $.60 \times 3 \times 62.5 \times .0055 = 62.0$ lb

Also, since in assisted takeoff, using the jet units for 15 to 20 sec., with between 15 and 20 lb of fuel consumed the craft weight will be less as soon as it is airborne and during operation as an autogiro, than in the case of the craft becoming airborne by means of mechanical direct takeoff, since in this latter case, the aircraft must always carry the weight of rotor starter and pitch change mechanism, with a consequent reduction in performance and/or payload

In comparison to the hub driven helicopter, the contemplation of an autogiro using rocket type jets for assisted takeoff will eliminate original and maintenance cost of the hub driven 'copter transmission, also noise and vibration usually associated with a transmission of this type. It is also shown later that the blade of a jet-driven helicopter, because of its lower incidence and driving force applied at the blade tip, has lower resultant bladeroot stresses than a blade in the hub driven type of 'copter

With potential performance either as an autogiro or jet driven helicopter, and considering the very superior performance of the combination, also relative simplicity of the craft in comparison to the hub driven types of helicopter, it is believed that the autogiro with jet-assisted takeoff will be an exceedingly useful machine—at least until such time as fuel rate for the completely jet-propelled 'copter is no longer a problem, and weight and size of the jets are reduced to practical proportions

In the calculation of blade pitch required for operation as a low powered jet-driven helicopter, it was found that the value was 5.25 deg—only .25 above that used as an autogiro The δ_3 tilt, for a relatively low powered jet-driven rotor, could therefore be rather small—of the order of 10 deg On the other hand, use of a δ_3 tilt of some 30 deg would give a decided increase of blade pitch, when jet-drive is used, with a slight reduction in tip speed, but a probable overall increase in quantitative performance.

One probable additional advantage from the jet drive is the reduction of coning angle on larger size single-rotor craft. In an analysis made some years ago on autogiros of a large range of gross weights, the writer found that blade weight was practically a constant proportion of gross weight In the hub driven helicopter, with rotor maintaining a constant tip speed, rotor driving torque increases very rapidly with gross weight, and in larger sizes, rotor weight will increase considerably faster than gross weight because of additional structure required in plane of rotation On the jet driven type, the jet force is almost balanced (with jet at blade tip), leaving a small reaction force at the drag hinge approximately one-quarter the actual jet force, so that the question of blade structure in plane of rotation is no greater than with friction dampers at the blade root of an autogiro

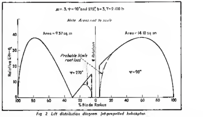


Fig 2 Lift distribution diagram jet-propelled helicopter

Analysis of Cierva's equation, giving rotor angular velocity as:

$$\omega = \gamma \sqrt{\frac{T}{\rho\sigma\pi}} \times \frac{1}{R^2}$$

indicates that, when operating as an autogiro, tip speed is constant so long as geometrical similarity—same blade pitch, solidity, and disk loading—is maintained Also, analysis of the coning angle, giving $\beta_0 = 3\,gR/(\Omega R)^2\,[.59\,(T/b\rho) - .5]$ indicates that $\beta_0 \propto R$ (and therefore $\propto T^{1/2}$) for geometrical similarity. Cierva also set a limit to coning angle in operation of an autogiro as $\beta_0 \cong \tan^{-1} \frac{1}{6}$—that is, β_0 must never exceed 9.45 deg It has been found that β_0 for the autogiro used as an example, at 2,100 lb. gross weight, is 4.67 deg at $\mu = .5$, and for an autogiro four times this size, maintaining geometrical similarity, β_0 would be 9.33 deg—just about the upper limit recommended by Cierva By addition of the driving units at 2.5 lb each (for the assisted takeoff autogiro), β_0 becomes (for the 2,100-lb. craft, operating as an autogiro at $\mu = .5$) 4.25 deg, and for a craft four times the size of the example, $\beta_0 = 8.5$ deg—well below the limit established by Cierva. Also, at the higher tip speeds of jet operation, coning angle will be still lower, with no likelihood of detrimental effects at the highest forward speeds

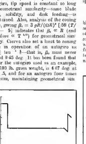


Fig 3 Blade weight distribution, jet-propelled helicopter

Loads Developed in Blades

With regard to loads developed in blades of a jet-driven helicopter or in autogiro blades with jet-assisted takeoff and landing, the following factors are to be considered In a rotary wing craft using jet-drive at blade tips for either complete drive, as a helicopter, or for use on an autogiro to furnish assisted takeoff and landing, com-

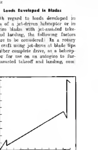


Fig 4 Distribution of vertical components of centrifugal force jet-propelled helicopter.

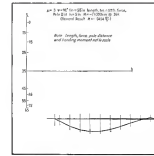


Fig 5 Primary bending moment jet-propelled 'copter

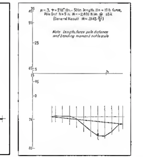


Fig 6 Primary bending moment jet-propelled 'copter

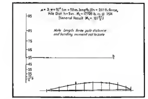


Fig 7 Relief bending moment jet-propelled 'copter.

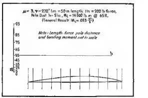


Fig 8 Relief bending moment jet-propelled 'copter.

bination of moments and loading will be of same nature as in the hub driven helicopter blades, and will differ only in magnitude of loads. Centrifugal force, at a given rotational speed, will be increased because of the concentrated weight of the jet-driving units at each blade tip. Magnitude and distribution of bending moments in plane of lift will also be altered for the same reason and because with higher rotor tip speeds, a given forward speed will be attained at a lower tip speed ratio

Loading of blade in the plane of rotation will be modified, since driving force is now applied at the blade tip rather than at the blade root. Assuming that the rotor is started with full jet force, and that there is a possibility of operating in gusty air, it would appear logical to use the same design factors as for the direct takeoff autogiro and hub-driven helicopter—the vector addition of a design bending moment in plane of rotation, given by a jet force at the blade tip 2.25 times that calculated for steady operation, and a design bending moment in plane of flapping 4.0 times the normal blade moment

For flight, maximum absolute design value of the bending moment in plane of lift would be combined vectorially with the maximum bending moment in plane of rotation (due to the jet-driving force at the blade tip) for a tip speed ratio 20 to 25% above high speed, and stresses due to this resultant bending moment are combined with stresses due to centrifugal force The fatigue analysis could be made (conservatively) either at this higher tip speed ratio or at the ratio corresponding to cruising speed

For the example of the application of the above method, a completely jet-driven helicopter will be used, having the following characteristics: Gross weight, 2,100 lb, 40 25 ft dia 3 blade rotor, jet force of 74 lb per blade, tip speed $\Omega R = 700$ fps, and 05 solidity It will be assumed that the concentrated weight at blade tip, due to driving jet, is 3 0 lb As obtained by performance estimates, a tip speed ratio $\mu = 3$ corresponds to 1 24 V_{max} for this craft, and this value of tip speed ratio will conservatively be chosen for the derivation of bending moments in both plane of lift and rotation, and for fatigue analysis Average blade pitch θ_0 is 09 rad (5 15 deg), with pitch change $\theta_1 = \pm$ 0387 rad ($\pm$ 2 22 deg) for this tip speed ratio

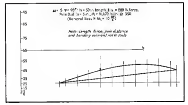


Fig 9 Derivation of relief bending moment diagram

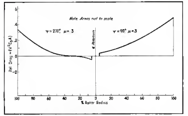


Fig 10 Relative drag, jet-driven 'copter blades

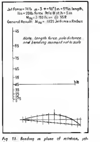


Fig 11 Bending in plane of rotation, jet-driven copter

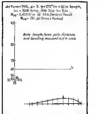


Fig 12 Bending in plane of rotation jet-driven 'copter.

Lift distribution diagrams for blades at $\psi = 90$ and 270 deg for a tip speed ratio $\mu = 3$, are shown in Fig 2, while Fig 3 shows the blade weight distribution with 3 lb concentrated weight at the blade tip, and Fig 4 depicts distribution of the vertical components of centrifugal force corresponding to the weight distribution in Fig 3 In Table I, the various elementary forces which hold the blade in equilibrium (in plane of lift) are derived, while in Figs 5 and 6, primary bending moments are derived for $\psi = 90$ and 270 deg, and corresponding relief bending moments are derived in Figs 7 and 8 For this relatively low tip speed ratio, with the concentrated weight of 3 lb. at the blade tip, Fig 5 shows a considerable decrease in maximum primary bending moment for advancing blade ($\psi = 90$ deg) over that which would be obtained for $\mu =$ 5, no concentrated weight at blade tip A small positive primary bending moment is shown near the blade tip in Fig. 5 Values for relief bending moment corresponding to maximum primary bending moment (Figs. 7 and 9) show very little change over those which would be obtained at a higher value of μ. For the retreating blade ($\mu = .3$, $\psi = 270$ deg, Fig 6), there is a small positive primary bending moment on the inboard .35 blade radius, with a larger negative primary bending moment (reaching a maximum value at 65R) in the outer .65 blade radius.

Since the complete blade analysis requires the vector addition of bending moments in plane of lift and in plane of rotation, the bending moments in plane of rotation due to a driving force of 74 lb at the blade tip will be derived for advancing and retreating blades ($\psi = 90$ and 270 deg) at $\mu = .3$ Basic value of blade pitch θ_0 has already been calculated as 5 15 deg, with cyclic pitch change θ_1 of $\pm$ 2 22 deg For $\psi = 90$ deg, blade pitch is then (5 15−2 22) = 2 73 deg, with a value of (5 15 + 2.22) = 7 37 deg for $\psi = 270$ deg The drag coefficient, C_D, (NACA 23015 airfoil[1]) for $\theta = 2$ 73 deg above zero lift is 0121,

[1] NACA Technical Note 587 *Tests of NACA Airfoils in the Variable Density Wind Tunnel, Series 230*, by E N Jacobs and R M Pinkerton

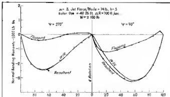


Fig 13 Resultant normal bending moments blades of jet-propelled 'copter

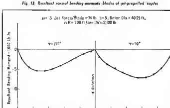


Fig 14 Resultant design bending moments blades of jet-propelled 'copter

and for $\theta = 7.37$ deg above zero lift, C_D is .030 Drag distribution is calculated (Table II) and is shown graphically in Fig 10 In the jet driven 'copter there is a constant force applied at each blade tip hence each blade is subjected to a constant torque rather than a varying torque, as in the hub driven helicopter This facilitates the solution for the equilibrium conditions, at any tip speed or phase angle, for the blade in plane of rotation From Fig 10, for $\mu = .3$, $\psi = 90$ deg., it is found that the centroid of drag force is at .692 R For the equilibrium condition about the drag hinge of $\Sigma M = O$, we have $74 \times 233.75 = D \times [(.692 \times 241.5) - 7.75]$, and drag $D = (74 \times 233.75)/159.25 = 108.5$ lb

For equilibrium of forces in the plane of rotation, a side force is required at the drag hinge of $108.5 - 74 = 34.5$ lb

For $\psi = 270$ deg, with drag centroid at .785 R, $D = (74 \times 233.75)/182.4 = 94.6$ lb, with a drag hinge side force of 20.6 lb.

For $\psi = 90$ deg, area of diagram corresponding to 108.5-lb drag is 5.08 sq in, giving a drag force of 21.4 psi of diagram For $\psi = 270$ deg, area of diagram corresponding to 94.6 lb drag force is 1.835 sq in, giving a drag force of 51.6 psi of diagram Operating at a tip speed ΩR of 700 fps, the centrifugal force at the blade root becomes $7,200 (700/400)^2 = 22,000$ lb For $\psi = 90$ deg, there is a small lag angle of 5.4 min (.09 deg), while for $\psi = 270$ deg, lag angle is 3.22 min (.054 deg) The lag-angles are of small value because drag hinge side forces, in the jet-driven 'copter, are reduced to approximately 1% of the value of 2,000 to 3,000 lb found in the hub-driven 'copter Also, if the jet force were applied at exactly the drag centroid of a blade, there would be zero lag or lead angle, due to rotor driving means

With the small lag angles associated with the jet driven rotor, components of centrifugal force tending to restore the blade to a radial position are (conservatively) neglected, and the problem of determination of bending moments in plane of rotation reduced to that of a simple beam, supported at each end, with a non-uniformly distributed load The elementary forces acting at each 10% increment of blade radius are calculated in Table III, while the bending moments are determined graphically in Figs 11 and 12 The bending moment in plane of rotation due to a jet driving force is used directly, with no calculation of centrifugal relief of bending (This again is a conservative method of applying these moments, since analysis will show that a number of simplifying and conservative assumptions are made Also, stiffness in plane of rotation is usually considerably greater than for spar alone, and any bending in plane of rotation will be distributed between spar and superstructure in proportion to their relative EIs) In plane of lift, the calculation of centrifugal relief from bending, due to blade flexibility, will be retained At a tip speed of 700 fps, with blade weight of 70.2 lb, and C G at .454R giving equivalent weight for a uniformly distributed weight blade of 63.7 lb, the coning angle β_0 is:

$$\beta_0 = \frac{96.48 \times 20.125 \times 57.3}{490,000} \left[59 \times \frac{700}{63.7} - .5 \right]$$

$$= .217 \times 5.98 = 1.3 \text{ deg}$$

Flexibility factor K as previously calculated, is 2,140 in-lb per deg

In Table IV, resultant normal bending moments in flight at $\mu = .3$, are calculated, and shown graphically in Fig 13 Design bending moments (limit load factor of 4.0 to both primary and relief bending moments in plane of lift, and limit load factor of 1.5 to those in plane of rotation, with factor of safety of 1.5 to resultant moment), are calculated in Table V, and shown graphically in Fig 14

Checking for the ground condition, the blade moment in plane of flapping outboard .10R (end of blade sleeve), as given by a blade weight outboard this station of $70.2 - 14.4 = 55.8$ lb, with C G at .554R is:

Blade moment $= 55.8 \times 240 \times .554 = 7,407$ lb-in

Design flapping moment $= 4 \times 7,407 = 29,628$ lb-in

Moment in plane of rotation at .10R, due to jet-driving force of 74 lb is: $M_{PR} = 240 \times .9 \times 74 = 15,990$ lb-in

Design $M_{PR} = 15,990 \times 2.25 = 35,900$ lb-in

Resultant design bending moment at .10R is

$$\text{Res. M} = (29,628^2 + 35,900^2)^{1/2} = 46,600 \text{ lb in}$$

With section modulus $Z = .1939$ in.³, $f_b = 46,600/.1939 = 240,500$ psi Value $f_b/F_b = 240,500/179,500 = 1.34$, that is for above condition of stress, spar at .10R should have 34% greater strength than the 1¾-in .095 steel spar of 150,000 psi U T S considered This additional local strength could be obtained either by the addition of a sleeve over this section, or by using a step tapered spar of constant gage, and with o.d. increased at .10R. to give the desired section modulus of .260 in³ (or greater) An .095 spar of 2-in o.d. has a section modulus Z of .2585 in³, with D/T ratio of 21.05, giving an allowable bending modulus of rupture (for 150,000 psi U T S) of $F_b = 174,500$ psi Using the 2-in. .095 spar at .10R, $f_b = 46,600/.2585 = 180,000$ psi, with $f_b/F_b = 180,000/174,500 = 1.032$, with a margin of safety of $(1/1.032) - 1 = -.031$ —probably satisfactory Spar may then be reduced in diameter to 1¾ in at a point outboard that station where the resultant design bending moment is less than 34,800 lb in

For the design flight condition of $\mu = .3$, Fig 14 shows greatest absolute value of design resultant bending moment as 7,200 lb-in at .58R Comparing design rotor tip speed for operation as a jet driven helicopter, or, in event

Table I—Derivation of Elementary Forces Holding Blade of Jet-Propelled Helicopter in Equilibrium—Plane of Lift.

$\mu = .3$; $W = 2\,100$ lb $b = 3$, Rotor radius (outbd centerline flapping hinge) = 240 in

		$\psi = 90$ deg.			$\psi = 270$ deg.		
% R	Gravitational Δf_w, lb	Vert. component of centrifugal, Δf_c lb	Lift Δf_L, lb	Resultant Δf_R lb	Vert. component of centrifugal Δf_c, lb	Lift, Δf_L lb	Resultant, Δf_R lb
5	14 4	16 5	−17 3	13 6	11 3	−8 4	17 3
15	6 0	21 9	−67 2	−39 3	15 1	−20 3	−2 2
25	6 0	34 7	−87 7	−47 0	23 8	−9 0	20 8
35	6 0	48 4	−99 1	−44 7	33 1	−17 1	22 0
45	6 0	62 1	−108 6	−41 9	42 7	−48 0	− 2
55	6 0	75 9	−112 2	−30 3	52 1	−76 4	−18 3
65	6 0	89 7	−111 5	−15 8	61 5	−98 5	−31 0
75	6 0	103 3	−103 7	5 6	70 6	−111 0	−34 1
85	6 0	117 2	−86 5	36 7	80 3	−105 5	−19 2
95	7 6	165 5	−47 7	125 6	113 3	−65 9	44 7

Lift carried by blade at $\psi = 90$ deg $F_L = 1\,400 \times \frac{14.1}{23.47} = 840$ lb

$M_L = 840 \times .63 \times 240 = 127\,200$ lb in

$M_w = 6\,940 + (3 \times .975 \times 240) = 7\,642$ lb in

$M_r = (127\,200 - 7\,642) = 119\,558$ lb in

$F_1 = \frac{119\,558}{.679 \times 240} = 735$ lb

$F_1 = 91.5$ psi of diagram (Fig. 4)

$f_L = 59.6$ psi of diagram (Fig. 2)

Lift carried by blade $F_L = (1\,400-840) = 560$ lb

$M_1 = 560 \times .666 \times 240 = 89\,600$ lb in

$M_w = 7\,642$ lb in

$M_r = (89\,600 - 7\,642) = 81\,958$ lb in

$F_c = \frac{81\,958}{.679 \times 240} = 504$ lb

$F_c = 62.7$ psi of diagram (Fig 4)

$f_L = 30.0$ psi of diagram (Fig. 2)

Table II—Calculation of Relative Drag Distribution on Jet Driven Helicopter Blade $\psi = 90$ and 270 deg

$\mu = .3$ Rotor solidity = .05 Jet force per blade = 74 lb ; Torque per blade = 1 480 lb —ft

	$\psi = 90$ deg. $C_D = .0121$			$\psi = 270$ deg. $C_D = .030$		
% R	Rel Vel	(Rel. Vel)²	(Rel Vel)² × C_D × A*	Rel Vel	(Rel Vel)²	(Rel Vel)² × C_D × A*
7 5	1 25	1 56	.0158	− .71	.567	− .0127
15	1 50	2 25	.0272	− .50	.25	− .0156
25	1 833	3 36	.0352	− .167	.028	− .0018
35	2 167	4 71	.1124	.167	.028	.0018
45	2 50	6 25	.1566	.500	.25	.0158
55	2 833	8 02	.2034	.833	.694	.0437
65	3 167	10 03	.2544	1 167	1 36	.0857
75	3 500	12 25	.3106	1 50	2 25	.1417
85	3 833	14 6	.3724	1 833	3 36	.212
95	4 167	17 40	.442	2 167	4 71	.297

* For solidity of .05 A = .833 the value used in example of hub-driven helicopter where solidity was .06

Table III—Determination of Elementary Forces Acting on Blades of Jet-Propelled Helicopter in Plane of Rotation

$\mu = .3$ Rotor solidity = .05 Jet force per blade = 74 lb., Torque per blade = 1490 lb —ft

	$\psi = 90$ deg		$\psi = 270$ deg.	
% R	Elementary area, sq in (from Fig. 3)	Elementary drag force lb.	Elementary area sq in	Elementary drag force lb
7 5	.05	1 07	− .545	−2 82
15	.15	3 21	− .035	−1 81
25	.22	4 70	− .01	− .52
35	.30	6 42	.01	.52
45	.40	8 56	.035	1 81
55	.51	10 90	.11	5 69
65	.64	13 70	.21	10 85
75	.78	16.67	.30	15 47
85	.93	19 90	.53	27 38
95	1 10	23 50	.73	37 70

Table IV—Resultant Normal Bending Moments in Blades of Jet-propelled Helicopter.

$\mu = .3$ Rotor solidity = .05, Jet force per blade = 74 lb Torque per blade = 1490 lb —ft

	$\psi = 90$ deg					$\psi = 270$ deg.				
% R	Primary bending moment, M lb -in	Relief bending moment M_1 lb -in	Bending moment in plane of lift corrected for flexibility M_1 lb in	Bending moment in in plane of rotation M_{PR} lb in	Resultant bending moment M_{RR} lb -in	Primary bending moment, M lb.-in	Relief bending moment M_1 lb -in	Bending moment in plane of lift corrected for flexibility M_1 lb in	Bending in plane of rotation M_{PR} lb in	Resultant bending moment, M_{RR} lb -in
5	−1 500	3 000	−721	400	−825	225	2 500	120	150	193
15	−4 500	8 000	−1 160	1 200	−1 670	300	6 000	95	550	560
25	−6 630	13 900	−1 185	1 900	−2 230	425	9 000	100	900	905
35	−7 750	17 500	−1 000	2 500	−2 720	75	12 000	14	1 400	1 400
45	−7 500	21 000	870	2 900	−3 030	800	14 000	−135	1 800	1 805
55	−6 500	22 000	730	3 150	−3 270	−1 700	15 000	−265	2 200	2 220
65	−4 600	21 500	530	3 100	−3 150	−2 400	14 570	−390	2 400	2 430
75	−3 750	19 000	−350	2 800	−2 820	−2 350	13 000	−415	2 350	2 385
85	−500	14 000	−83	2 100	−2 100	−1 450	9 000	−340	2 000	2 025
95	+875	6 900	+250	900	+940	−190	4 000	−80	1,000	1,005

Table V—Resultant Design Bending Moments in Blades of Jet-Propelled Helicopter

μ = .3 Rotor solidity = .05 Jet force per blade = 74 lb, Torque per blade = 1,480 lb

% R	ψ = 90 deg. Limit load bending moment in plane of flapping, corrected for flexibility lb-in	Limit load bending moment in plane of rotation lb-in	Resultant limit load bending moment, lb-in	Design resultant bending moment, lb-in	ψ = 270 deg Limit load bending moment in plane of flapping, corrected for flexibility lb-in.	Limit load bending moment in plane of rotation lb-in	Resultant limit load bending moment, lb-in	Design resultant bending moment lb-in
5	−1,130	600	1,280	1,920	195	225	300	450
15	−1,440	1,800	2,510	3,760	125	770	785	1,180
25	−1,300	2,850	3,140	4,710	120	1,350	1,355	2,035
35	−1,185	3,780	3,940	5,920	15	2,100	2,100	3,150
45	−960	4,350	4,450	6,690	−150	2,700	2,705	4,060
55	−795	4,725	4,790	7,190	−300	3,300	3,315	4,970
65	−578	4,650	4,670	7,008	−440	3,600	3,630	5,445
75	−390	4,200	4,220	6,330	−495	3,525	3,610	5,415
85	−65	3,150	3,155	4,730	−415	3,000	3,030	4,545
95	+340	1,350	1,395	2,090	−90	1,500	1,505	2,260

of power failure, as an autogiro, tip speed for the jet-driven condition is 700 fps while it is only 439 fps for operation as an autogiro. It is considered logical in the jet-driven rotor condition to use a 2.25 design factor on centrifugal force, as used for the condition of maximum rotor rpm in the direct takeoff autogiro. This factor of 2.25, for a tip speed of 700 fps, gives substantially the same final result as a factor of 6.0 applied to centrifugal force developed at a tip speed of 439 fps. Since centrifugal forces are proportional to tip speed squared (in the same rotor), the exact factor to be used for the higher tip speed, based on 6.0 for autogiro, with tip speed of 439 fps, would be 6.0 $(439/700)^2$ = 2.36—very close to the factor of 2.25 actually used.

Weight outboard $.58R$ is (from Table I) 27 lb, with C.G at $.694R$, with C.F developed at 700-fps tip speed (34.8 rad/sec) of:

$$\text{(Applied) C.F.} = 34.8^2 \times \frac{27}{g} \times 16.15$$
$$= 16,440 \text{ lb}$$

$$\text{Design C.F.} = 2.25 \times 16,440 = 37,000 \text{ lb}$$

Spar fiber stresses and stress ratios at $.58R$, due to the above design bending moment and centrifugal force, for $1\frac{3}{4}$ in. o.d. .095 spar with 150,000 psi U.T.S. are

$$f_t = \frac{7,200}{.1939} = 37,200 \text{ psi}$$

$$\frac{f_b}{F_b} = \frac{37,200}{179,500} = .207$$

$$f_t = \frac{37,000}{.4939} = 75,000 \text{ psi}$$

$$\frac{f_t}{F_t} = \frac{75,000}{150,000} = .500$$

Combined stress ratio = .707 — O K

Using data from Table IV and Fig 14, it is found that the greatest variation in bending moment in plane of lift between ψ = 90 and 270 deg is at $.20R$. The different forces and moments acting on the spar at this point will be analyzed from the standpoint of reversed bending (fatigue). With a rotor angular velocity of 34.8 rad/sec, blade weight outboard $.20R$ of 49.8 lb, and C.G. location from centerline of rotation of 12.25 ft, a steady centrifugal force is developed at $.20R$ of:

$$\text{C.F.} = 34.8^2 \times \frac{49.8}{g} \times 12.25 =$$

22,950 lb

Bending moments in plane of lift, for ψ = 90 deg, are −1,200 lb-in, and for ψ = 270 deg, + 100 lb-in. In plane of rotation, for ψ = 90 deg, bending moments are 1,560 lb-in and for ψ = 270 deg, 725 lb-in. With .095 spar of $1\frac{3}{4}$ in. o.d., and again reducing F_t = 179,500 psi to 150,000 × 1.197 where 1.197 is the form-factor for a round tube of D/T = 18.4, the following fiber stresses will be developed:

$$\text{Centrifugal force: } f_c = \frac{22,950}{.4939} = 46,500 \text{ psi}$$

ψ = 90 degrees

$$\text{Plane of lift} \quad f_b = \frac{1,200}{.1939 \times 1.197} = 5,170 \text{ psi}$$

$$\text{Plane of rotation} \quad f_b = \frac{1,560}{.1939 \times 1.197} = 6,720 \text{ psi}$$

ψ = 270 degrees

$$\text{Plane of lift} \quad f_b = \frac{100}{.1939 \times 1.197} = 431 \text{ psi}$$

$$\text{Plane of rotation} \quad f_b = \frac{725}{.1939 \times 1.197} = 3,120 \text{ psi}$$

Considering upper and lower fibers of spar in combination with forward fiber (toward blade leading edge) and rear fiber, the following steady and varying stresses are obtained:

For ψ = 90 deg, stresses are—

Upper forward	$46,500+(5,170^2-6,720^2)^{1/2}$ = 46,500 − 4,300 psi
Upper rear	$46,500+(5,170^2+6,720^2)^{1/2}$ = 46,500 + 8,490 psi
Lower forward	$46,500-(5,170^2+6,720^2)^{1/2}$ = 46,500 − 8,490 psi
Lower rear	$46,500+(6,720^2-5,170^2)^{1/2}$ = 46,500 + 4,300 psi

For ψ = 270 deg, stresses are—

Upper forward	$46,500-(431^2+3,120^2)^{1/2}$ = 46,500 − 3,150 psi
Upper rear	$46,500+(3,120^2-431^2)^{1/2}$ = 46,500 + 3,090 psi
Lower forward	$46,500-(3,120^2-431^2)^{1/2}$ = 46,500 − 3,090 psi
Lower rear	$46,500+(431^2+3,120^2)^{1/2}$ = 46,500 + 3,150 psi

Worst stressed fibers from the standpoint of reversed bending would appear to be either the upper rear or lower forward fibers. Again using the Johnson Goodman formula, as used in the example of the hub-driven helicopter we find the range ratios, allowable stresses in reversed bending, and margins of safety as follows:

Range ratio for upper rear fiber is 46,500 (+ 8,490, + 3,090) = 54,990 to 49,590 psi, with r = 49,590/54,990 = .903, with S_{max} = 5 × 150,000/(1 − (.5 × .903) = 136,500 psi

With an allowable fiber stress of 136,500 psi, and a maximum stress shown of 54,990 psi, margin of safety for the upper rear fiber is (136,500/54,990) − 1 = 1.49

Range ratio for the lower forward fiber is 46,500 (− 8,490, − 3,090) = 38,010 to 43,410 psi, with r = 38,010/43,410 = .852, with S_{max} = 5 × 150,000/1 − (.5 × .852) = 130,800 psi

With an allowable fiber stress of 130,800 psi, and a maximum stress of 43,410 psi, margin of safety for the lower forward fiber is (130,800/43,410) − 1 = 2.01

Upper rear fiber, with a margin of safety of 1.49 is therefore critical at $.20R$ in reversed bending, for μ = .3.

A blade for a jet-driven helicopter, designed to the above factors, and using methods of obtaining forces and moments as outlined previously should give a satisfactory structural performance.

The use of any general method of structural analysis may be modified, in detail, to suit a particular condition, or may be modified to suit new ideas for convenience of use developed by an individual designer. It is believed the general methods of analysis for blades of rotary wing craft as set forth here will be useful to any designer, who may make such alterations in detail (as for instance, lift or torque distribution for the blades and weight distribution for an individual design) as he feels are desirable, either in light of more advanced knowledge on the subject, or for the requirements of a specific design.

Aircraft Acoustical Problems And Possible Solutions

PART II*

By K. R. JACKMAN, Chief Test Engineer, Consolidated Vultee Aircraft Corp., San Diego

Presenting new tools and techniques for determining proper power plant location and other factors necessary to increase airplane efficiency by lowering noise levels.

Isolation of the passenger cabin walls and flooring from vibrations of the fuselage structure is a fundamental of good soundproofing. There are many methods of vibration-isolating the cabin wall from the primary structure, but one of the most practical applications of this "inner cabin" principle (filed for patent by R. F. Norris of the Burgess-Manning Co., Chicago, in 1935 and patented in 1938) is shown to the left of Fig. 9.

It will be noted that the walls and floor are "sprung" in this patent disclosure. It is interesting to note the similarity in patent claims of J. B. Darragh, Jr., of Lockheed, patented 1941. The basic principle of wall and floor isolation appears to have been covered in the earlier Burgess patent.

To prove the acoustical value of such cabin treatment, the Burgess Co. in 1934 treated a Boeing 247D for United Air Lines as shown in Fig. 10. Such a record photograph is interesting in two respects. It indicates the progress made in aeronautical structural design in 12

* Based on paper presented before ASME Aviation Section, Los Angeles, and Semi Annual Convention, Detroit.

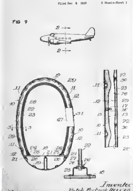
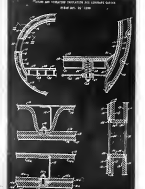


FIG. 9



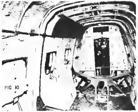


FIG 10

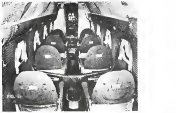


FIG. 11

...yr in removing spurs from cabin areas, increasing the space per passenger, etc., but it also indicates that we may now have to return to a soundproofing technique tried successfully at that time and then forgotten. Fig 11 shows the finished interior of this 1934 transport. The writer was told recently by Ralph Leadbetter, director of engineering and development for Burgess-Manning, that this Boeing was approximately 6 db higher in overall noise level than its 1934 airline competitor, the early Douglas DC-2, at the time these acoustical changes were made. By installing this "inner cabin" and eliminating some bad wall resonances, the cabin level was reduced the necessary 6 db and the two planes were again competitive in passenger acoustical comfort.

To try out an installation as complicated as a "light-weight inner cabin", with its difficult to compute spring constants, structural requirements such as large seat loads, luggage rack supports, ventilation and heat ducting, and acoustical or vibration resonance periods, in a complete airplane, without a full scale test, would probably be courting trouble. Here again the Convair sound cabins offer a method for a relatively inexpensive and rapid test approach.

FIG 12

Fig. 12 shows the simplicity of this acoustical test method of using a discarded fuselage section, in this instance the nose portion of an XB-32 which had survived explosive decompression and gunfire tests and had thereafter been repatched and repaired. Sound Cabin No. 1 was mounted on a suitable wheeled stand which could be rolled with ease to the engine-propeller combination being tested.

In the upper view, a ground survey is being made of the No. 1 P&W R-1830-94 engine on a PB4Y-2 airplane turning an 11 ft 7-in. dia. 3-blade Hamilton Standard propeller. In this instance the exhaust exit was on the right rear portion of the nacelle, away from the cabin. In the lower view the same cabin is checking the noise levels at a point 25 ft aft of the propeller plane on an XB-32.

In the latter case the No. 4 P&W R-3350-23 engine was turning a 16 ft 8-in. dia. 4-blade Hamilton Standard propeller. The exhaust exits are dual in this case, each from a separate supercharger and emerging from the two sides of the nacelle under the wing.

Sound Cabin No. 2 was taken from the rear fuselage portion of a salvaged Convair plane. It was relatively easy and inexpensive to cut off this fuselage section with an acetylene torch, place two heavy double wooden bulkheads at each end, mount on a portable stand, and roll it to the engine being tested. By using the actual noise source in question, and a full scale fuselage structure, many of the questionable phases of acoustical laboratory tests have been eliminated. A closer approximation to flight conditions can thus be maintained than has heretofore been possible in aircraft, other than the expensive operation of soundproofing the complete flight article.

Incidentally, the plane which provided Sound Cabin No. 2—a Convair Model 39—had an interesting history. This experimental plane used portions of production military planes. On a B-24 Liberator wing, nacelle, and landing gear combination was placed an overgrown 10 ft. 6-in. dia. fuselage, more suitable than the former 7 ft. 4-in. wide fuselage on the B-24 for large volume cargo storage. Inserting this larger fuselage between the inboard nacelles cut down the conventional B-24 propeller-fuselage clearance from 23½ to 7¾ in.

The larger radius of curvature of the new fuselage, its lightweight construction, and the low propeller clearance had the inevitable effect of considerable lateral fuselage wall vibration in the plane of the inboard propellers at propeller blade frequency. This is a research problem we have probably all attempted to overcome at one time or another inasmuch as this source of vibration probably accounts for most of the retransmitted noise in modern commercial plane cabins.

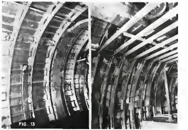


FIG. 13

Convair made several attempts to reduce fuselage wall and floor vibration in the structure at the propeller plane shown to the left of Fig. 13. Since it was obvious that the passage of each propeller blade past the fuselage was deforming the wall structure, the skin, stringer, and belt frame combination was stiffened by doubling the number of belt frames and by deepening them. By this temporary reinforcement, together with some external plywood baffles, the original radial deflection of .022 in. DA on a beltframe at 5 ft. above the floor level was reduced to .006 in. DA, with a structural weight addition of 422 lb.

A more efficient design of reinforcing this propeller-plane area of the fuselage was tried, as shown in the right-hand portion of Fig. 13, by designing more rigid tapered beltframes with fore-and-aft restraint. The vibration amplitude was then .009 in. DA. with a structural weight increase of 201 lb. over the base design.

The gruesome details of this redesign problem are given to warn innocent designers who might attempt to use 8-in. propeller-fuselage clearances on large diameter fuselages near powerful engines swinging wide-blade propellers. The beneficial effect of increasing the clearance to 20 in. or more may have far greater effect on passenger comfort than is indicated by the 4 db overall noise reduction predicted by Dr. Beranek in charts which will be presented later. The increase in propeller-fuselage clearance near wide-blade tips will materially reduce the wall and floor vibration and rapidly increase passenger comfort.

FIG. 14

Fig. 14 shows the Convair Sound Cabin No. 2 adjacent to the PB4Y-2 No. 1 engine-propeller combination, at the conventional 12-in. propeller-fuselage clearance. Note the door and ladder on the outboard side of the cabin to permit personnel entrance during or between noise tests.

Fig. 15 indicates the differences in the

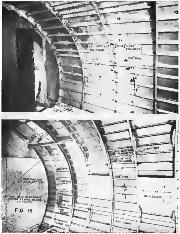


FIG 15

structure and dimensions of the two sound cabins. No. 1 has 2¾ in. deep beltframes against the .032-in. aluminum alloy skin at 24-in. spacing. The 1 x .050 in. Z stringers, spaced at approximately 6¼ in., pass through the notched beltframes. The cabin diameter varies from 110 in. at the forward end to 114 in. at the aft end. The 94 in. long by 103 in. wide flooring, composed of several layers of ¾ in. plywood, is adequately caulked to prevent noise entrance from below. Head clearance at the centerline of the cabin is 72 in. to the lower flanges of the beltframes. Narrow weatherstripped doors are fitted at both ends through 3-layer plywood bulkheads. Additional steel bulkheads and doors still further protect the cabin ends against noise leakage. There are no windows in this test cabin.

Sound Cabin No. 2 (shown in the lower part of Fig. 15) has many features found in current plane designs but absent in the earlier Cabin No. 1. This No. 2 cabin has a 14 x 16 in. x .081 in. Plexiglas window installation. The 137-in. cabin length permits its present use as a two-compartment test chamber, the forward 56 in. long x 97 in. wide area representing a portion of the baggage compartment in the current Convair 240, and the rear 81 in. long x 97 in. wide area providing an exact replica of a portion of the passenger compartment.

The larger diameter and the floor location of this fuselage (123 in. dia. forward and 114-in. dia. aft) permits a head clearance of 87 in. between the ½ in. thick sandwich type flooring and the beltframe lower flanges.

Cabin No. 2 has 3 in. deep beltframes resting on ¾ x .040 in. Z stringers at 20 in. spacing. The stringers are spaced at 6 in. on the .032 in. aluminum alloy skin. A sealed door and metal bulkhead now divide the two compartments at the third beltframe aft of the double-plywood end bulkhead shown. Two heavy wooden bulkheads, spaced at 20 in. and treated with soundproofing form each end of the cabin so as to prevent noise leakage.

Fig. 16 shows an early calibration test of Cabin No. 2 prior to installation

FIG. 16

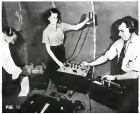


FIG. 17

of interior soundproofing and the bulkhead. The fine teamwork of Dr. Charles Krieger (left) and Verne Harrison (right) with this accurate sound analyzing and recording equipment, permits the rapid noise spectrum and octave band analyses mentioned earlier. A complete analysis of five flight conditions at nine locations in a large airliner (with some spectra, many octave band analyses, and some overall noise levels) was recently made by this pair and the writer in 45 min. Teamwork and complete understanding of the other man's signals and work have made this possible.

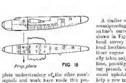


FIG. 18

A similar survey in Cabin No. 1 with soundproofing installed as in one of the airline's current DC-4 modifications is shown in Fig. 19. Such a cabin octave band survey made at the passengers' head locations at five positions and for three engine operating conditions usually takes only 20 min. engine operating time, possibly with several engine cooling periods intervening. With experienced upholsterers and adequate shop help a new trim cloth and sound-proofing material can be installed, tested, and

FIG. 19

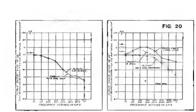


FIG 20

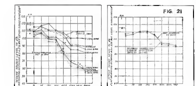


FIG 21

removed, the data reduced and studied, conclusions drawn, and a second installation started in less than five days.

So much for instrumentation, test methods, and the Convair sound cabins. How about the results? Do the data taken adjacent to one engine on the ground predict the acoustical performance in a four-engined transport at cruising conditions?

Tests made to date indicate that in some instances the agreement is within several decibels throughout the octave spectrum, and in others a calibration factor may be necessary to convert from the ground test results to flight predictions. More exhaustive tests are to be run which should answer these questions.

Early in the Convair acoustical program an attempt was made to correlate the noise level in a fuselage produced by one inboard engine during runup on the ground with the noise level at the same location in the same fuselage in flight using four engines at the same rpm. and power. If the noise spectrum should indicate approximately the same octave intensities with ground reflections in a single engine as exist in four-engine operation where aerodynamic noises, wind leaks, and tail surface vibrations influence the noise levels, the future of the Sound Cabin method of acoustical testing would look bright indeed.

Noise surveys were made in flight and on the airport at the left forward cabin seat of the 14-seat arrangement in the modified Liberator transport shown in Fig. 18. This plane was soundproofed with 2 in. of XAA-PF fiberglas (.050 lb. sq. ft.) in the propeller area and covered with a .094 lb. sq. ft. Bedford cord trim cloth. A .26 lb. sq. ft. medium-nap carpet surfaced the floor and .094 lb. sq. ft. Bedford cord upholstery covered the seats as shown in the lower right of Fig. 19.

The noise octave analyses made in flight at the left forward cabin seat, with the four P&W R-1830-94 engines operating at 1,800 rpm. (approximately 540 hp./engine), is shown by the solid lines in the left half of Fig. 20. The 12 ft. 1-in. dia. 3-blade Hamilton Standard propellers, geared 1:2, turned at 900 rpm. during the tests and developed tip velocities of 570 ft./sec. The propeller-fuselage clearance was 20.5 in. The indicated air speed was 175 mph. The low frequency level of 100 db and the speech frequency (1,200-2,400 cps.) of 73 db made the passengers feel quite comfortable and at ease.

The dashed lines in the right half of Fig. 20 show the unbelievably close correlation with the flight noises obtained by operating the left inboard (No. 2) engine on the ground with no forward speed effects. The upper dashed lines of this chart indicate the results of a similar test made on a Convair 39 in cruising flight at 2,000 rpm. (approximately 700 hp./engine) using four engines at 178 mph. The 11-ft. 1-in. diameter 3-blade propellers on these R-1830-94 engines had only 7⅝ in. fuselage clearance.

Sound Cabin No. 2 was tested at the standardized 12 PTC (propeller tip clearance) to a similar engine-propeller combination on the airport with the test results shown by the solid line on the graph. The ground Sound Cabin tests appeared to be conservative by 2 to 7 db in the vital octaves. No soundproofing existed in either the fuselage or the sound cabin during these trials. These and several other similar tests indicate that calibration factors may be necessary to correlate sound-cabin results with the flight noise spectra of any desired plane. It may be that the sound cabins are always conservative, that is lower, in flight, in noise predictions.

So many variables may affect the noise spectrum in an airplane cabin that the isolation of each variable, such as cabin "standing wave" effects upon microphones, PTC, propeller tip shapes, direction of rotation of propeller relative to fuselage, engine speed and power, should be accomplished in a specific sound cabin prior to varying the cabin wall insulation. Because of the tremendous scope of such an investigation and the high cost of operating aircraft engines, Krieger, Harrison, and the writer decided early in the program to economize in time and engine life by surveying the two sound cabins at five points (center and near walls) at a seated passenger's head height and at three engine speeds. Instead of repeating these runs several times, involving the uncertainties of the exact duplication of engine operating conditions, it was decided economical of data reduction time to average the noise intensities at each octave band for the engine speeds tested, thus eliminating incorrect individual readings.

A good example of the plotted average results is shown at the left of Fig. 21 in which the R-1830-94 engine on a PB4Y-2 airplane was operated at 1,600, 2,000, and 2,300 rpm. adjacent (12 in. PTC) to Sound Cabin No. 1, at first without insulation and then with cabin insulation of 1-in. XAA-PF Fiberglas (.050 lb. sq. ft.), two sheets of "V-film" impervious septum (.009 lb. sq. ft.), and a heavy Seaman "Suntan" trimcloth (.085 lb. sq. ft.). The surface density of this soundproofing was approximately .20 lb. sq. ft. A medium-nap carpet (.15 lb. sq. ft.) covered the plywood floor. The average curve of the "bare" condition is seen to approximate the mean of the three engine speeds, in spite of the erratic nature of the low-frequency response at 2,000 rpm.

The soundproofed cabin results always appear more consistent, and the average more dependable than that of the bare cabin, probably due to the absence of reverberation in the insulated interior. Most of the curves presented in this series will therefore be the mean values of two or three sets of engine speeds or cabin locations.

Inasmuch as the sound cabins are only a portion of the length of the average commercial fuselage, a lengthening effect was attempted by maintaining highly absorbent surfaces on the interiors of the heavy end bulkheads. The right half of Fig. 21 indicates the slight difference existing in the noise spectrum at the centerline of Sound Cabin No. 1 with bare plywood bulkheads and then with the bulkheads covered with 1-in. XM-PF Fiberglas (.125 lb. sq. ft.) and Seaman "Suntan" trimcloth (.085 lb. sq. ft.), totaling the surface density of 0.21 lb. sq. ft. This bulkhead surfacing insulation was maintained throughout all the early calibration tests.

The left half of Fig. 22 indicates the variation of noise level over the length and breadth of Sound Cabin No. 1 at seated passenger head height when operated adjacent to the PB4Y-2 P&W R-1830-94 engine with several propeller-fuselage clearances. Each plotted point indicates the average overall noise level (db) for seven engine speeds and horsepower settings, from 1,600 rpm. and 500 hp. to 2,800 rpm. and 1,350 hp. The overall sound level in the bare cabin dropped approximately 5 db at each cabin location by increasing the propeller clearance from 4½ to 24 in. Similarly, insulating the cabin with 1-in. XM-PF and Suntan reduced the overall noise levels by approximately 4 db.

The right half of Fig. 22 illustrates the low-frequency variation and the high-frequency consistency found in various locations in Sound Cabin No. 1 when tested near the R-1830-94 engine. The insulation surface density of .20 lb. sq. ft. permitted the 110 db overall level to be reduced to 69 db at the 1,200-2,400 cps. octave band. At 75-150 cps. the cabin center was approximately 5 db quieter than it was within 8 in. of the outer walls.

Sound Cabin No. 2 was placed at 5⅜ and at 18 in. from the engine operating at a 0.56 gear ratio with an 11 ft. 7-in. propeller. The noise existing at the centerline of the bare cabin in the plane of the propeller is shown in the left half of Fig. 23. The overall noise appears to be reduced by 5 db and the total spectrum by approximately 3 db in increasing the clearance from 5⅜ to 18 in.

An almost similar reduction was noted (right half of Fig. 23) in soundproofed Cabin No. 1, also adjacent to the same PB4Y-2 power plant, by increasing the clearance from 12 to 24 in. The surface density of the 1-in. XM-PF Fiberglas (.125 lb. sq. ft.) and Seaman's "Suntan" trim cloth (.085 lb. sq. ft.) was .21 lb. sq. ft., in addition to the .032-inch 24ST skin density of .470 lb. sq. ft. The 112 db overall noise level with the insulation at 12 in. PTC gave an intensity in the frequency octave band of 1,200-2,400 cps. of 76 db at approximately 2,000 rpm. (700 hp./engine) with a propeller-tip velocity of 670 ft./sec. (Mach number 0.61).

A different condition exists with this same cabin, with identical insulation and at 12- and 24-in. PTC from the XB-32 power plant. It will be recalled that this noise source consists of a Wright R-3350-23 engine rotating a 16 ft. 8 in. 4-blade propeller at a .035 gear ratio. At the mean engine speed of 1,800 rpm. (1,070 hp./engine) the propeller tip velocity was 550 ft./sec. (Mach number 0.50) and the difference between the 12 and 24-in. propeller clearances again averaged 3 to 4 db, checking the Harvard propeller tip separation chart very closely. It is interesting to note the quieter operation in the R-3350 engine propeller, in spite of its 53% greater power, than in the R-1830 noise source. At 12 in. PTC the R-3350 source gave 107 db overall and 72 db in the 1,200-2,400 cycle octave. This acoustical difference has been noted by pilots operating both Liberator and B-32 type airplanes.

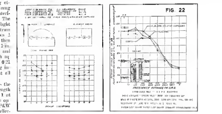


FIG 22

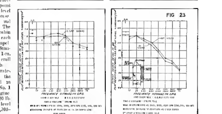


FIG 23

BEECH PRODUCING DELUXE BONANZA FOUR PLACER

Seating four and fully equipped with instrumentation for cross-country day-and-night flying, all-metal Beech 35 Bonanza is now in production and sells for $7 345 FAF, Wichita. Powered by 165-Continental, craft has top speed of 184 mph fully loaded. Bonanza's direct operating cost when used about 100-hr monthly, is claimed to be under 1½¢ passenger-mile, counting three passengers and not including pilot

Featuring butterfly tail and full equipment on standard,* all-metal tricycle-gear craft is stated to have 175-mph. cruising speed fully loaded with 165-hp. Continental. Especially designed for low operating costs, Bonanza has many passenger-and-pilot comfort features.

EXCEPTIONAL PERFORMANCE and completeness of equipment is claimed for the new Beechcraft Bonanza (Model 35) all-metal, four place low-wing personal plane. Now in production at the company plant in Wichita, Kans the craft has been tagged at $7,345 FAF.

Although this price admittedly puts the Bonanza in the upper brackets where initial cost is concerned, a look at the craft's specifications and operating costs (see table) shows that the company is offering a full measure to potential customers

Powered by a 6-cyl. 165-hp. Continental E-165 engine equipped with a pressure carburetor and Beech R 100 electrically variable pitch prop of 7 ft-4-in dia., the Bonanza is said to have a guaranteed top speed at sea level with full load of 184 mph. Cruising speed (115 hp.) is given as 175 mph at 10,000 ft, rate of climb 950 fpm, service ceiling 18,000 ft., and maximum range at 165 mph at 10,000 ft as 750 mi Takeoff with 10 mph wind takes 425 ft, and landing run is 315 ft Stalling speed with 30 deg flaps is said to be 46 mph, and without flaps 59 mph

Span is 32 ft. 10 in., length 25 ft. 2 in., and height 6 ft 6½ in. Wing area is 177 6 sq ft., maximum wing loading 14.35 lb/sq ft., and maximum power loading 15 45 lb./hp. Fuel capacity (two wing tanks) is given as 40 gal., and oil capacity is 11 qt. Gross weight is said to be 2,550 lb., empty weight 1,490 lb, and payload with full tanks 780 lb This latter figure covers four 170 lb occupants plus 100 lb of baggage.

Most prominent feature is the use of a butterfly tail, eliminating need for conventional rudder and fin surfaces It's stated that this innovation shows superiority over standard empennage from the standpoints of drag, stability, weight, economy, and maintenance. A conventional dual 3-control system is used, with right-hand pedals capable of being folded out of the way Toe brake pedals are standard on the left side, and throw-over wheel can be adjusted to two height positions. Elevator tabs are adjustable by means of a control wheel below the panel. Further controls are for cowl flaps, carburetor temperature, ventilation and heating, radio, electric landing gear and flap adjustments, and emergency manual landing gear actuation

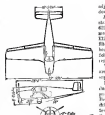
Turnover structure consists of deep box sections running up each side of the windshield to the top, with a branch crossing over above the windshield, and another running aft above the windowline joining similar sections rising between the front and rear windows and to the rear of the aft windows. A small "bad-weather" panel is provided on the left windshield in event of icing The cabin has a large door on the left side, and a retractable step facilitates entrance or exit. The windows, which may be opened while on the ground for ventilation, can be jettisoned in emergency. Another feature is installation of sunshades which may be adjusted over the windows to cut down glare

Wing design was chosen on the basis of comparative tests involving a laminar flow airfoil and a Beech version of the NACA 23000 series, with the latter finally picked for the Bonanza. Landing gear is of the retractable tricycle type with full-swiveling nose wheel equipped with shimmy damper. All wheels have Beech air-oil struts, stated to be capable of withstanding landing shock with a vertical descent component of over 600 fpm Main tires are 6 50x8 and nose wheel is 5x5 Wheels are Goodyear with single-disk hydraulic brakes. Main wheel fairing doors close after the wheels are fully extended, and open when the gear is retracted to close over the wells when actuation is complete The nose wheel is fitted with a guard to prevent stones or mud from being thrown up against the plane or prop The landing gear is so designed that it gives the wing a considerable angle of attack while at ground level, thus facilitating takeoff

Equipment listed in the Bonanza's specifications is to be installed in every production line model of the craft, and performance is based on complete installation. Here's a sectional breakdown of standard equipment fitted

Electrical and radio—24-amp-hr battery; electric motors for wheels and flaps actuation; radio receiver with beacon, broadcast, and marker reception; cabin loudspeaker, rotatable aural null loop with orientation dial on instrument panel, radio transmitter; automatic retracting trailing antenna, marker beacon antenna, and microphone and headset

Flight and engine instruments—Eclipse-Pioneer airspeed indicator, turn-and-bank, rate of climb, and compass; Elgin 7 jewel sweep second clock; modified C-12A outside air temperature gage, Eclipse-Pioneer tachometer, manifold pressure gage, and engine cluster unit consisting of fuel pressure, fuel quantity, oil temperature, oil pressure, ammeter, and cylinder head temperature gages



Lights—Two GE 4522 landing lights in wings, Grimes position and tail lights, Beech cabin, dome and ultra-violet instrument lights, and landing gear and flap position lights

Cabin equipment—Lucite ultra-violet wind-shields and windows; soundproofing full upholstery, including wall-to-wall rug; loudspeaker, four adjustable sunshades, map and glove compartments, four ash trays, cigarette lighter, "bad-weather" window for left pilot, adjustable and jettisonable rear windows

Engine equipment—Delco-Remy 2514 starter, 25-amp 1656-25 generator, 6221-25 voltage regulator, Cutler-Hammer 6041H105 battery relay; Carter 112-22 fuel pump; Beech carburetor air filter, stainless steel mufflers and cabin heaters, stainless steel exhaust manifolds, and B-11 vacuum pump, vacuum regulator, and oil separator.

Where names of equipment makers are not given, this information was not supplied

Before the Bonanza was put into production a very extensive program of prototype testing was carried out by Beech Two craft were built utilizing different airfoil sections. Prior to flight tests under all types of conditions, all the structural components of both craft are stated to have undergone fatigue testing the equivalent of 20 000 flying hours in addition to normal static tests required by CAA. Later, three production model planes were flown night and day on accelerated service tests These included rough-field landings and take-offs and operations during all types of weather Alternate crews and pilots are said to have kept the craft flying the maximum possible time during this proving period That this unusual program has proven its worth is indicated by the manufacturer's statement that all performance figures are guaranteed within 3%

Estimated Operating Costs of Beech 35 Bonanza
(Owner Operated)

		Business or Pleasure					Commercial Charter or Taxi Service				
		200 hr per yr	300 hr per yr	600 hr per yr	900 hr per yr	1200 hr per yr	200 hr per yr	300 hr per yr	600 hr per yr	900 hr per yr	1200 hr per yr
Fuel cost Gasoline consumption based on 115 hp cruising power includes normal warm up taxiing and climb[1] oil consumption (estimated as .075 gph of operation) includes 20% allowance for normal oil changes	Gasoline—10 gal @ $.22/gal	$2.20	$2.20	$2.20	$2.20	$2.20	$2.20	$2.20	$2.20	$2.20	$2.20
	Oil—.075 gal @ $1.20 gal	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09
		$2.29	$2.29	$2.29	$2.29	$2.29	$2.29	$2.29	$2.29	$2.29	$2.29
Depreciation cost Engine depreciation based on 4000 hr flying. Total hull depreciation spread over five-year with 30% residual value	Engine depreciation per hr	$ .50	$ .50	$ .50	$ .50	$ .50	$ .50	$ .50	$ .50	$ .50	$ .50
	Hull depreciation per hr	3.50	2.33	1.17	.78	.58	3.50	2.33	1.17	.78	.58
		$4.00	$2.83	$1.67	$1.28	$1.08	$4.00	$2.83	$1.67	$1.28	$1.08
Maintenance Hangar cost based on $300 rental per year. Repair parts and minor overhaul based on Beech records. Major overhaul based on 800 hr of operation.	Hangar rental and 100-hr check-up per hr	$2.25	$1.50	$ .75	$ .50	$ .37	$2.25	$1.50	$ .75	$ .50	$ .37
	Repair parts and major overhaul	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
		$3.75	$3.00	$2.25	$2.00	$1.87	$3.75	$3.00	$2.25	$2.00	$1.87
Insurance Equipment insurance includes all risk and crash. Public liability is on a $25 000/$50,000 basis. Property damage for $50,000. Passenger liability on $10,000 per seat for three seats.	Equipment insurance	$3.67	$2.45	$1.23	$ .82	$ .61	$5.51	$3.68	$1.83	$1.22	$ .92
	Public liability	.08	.05	.03	.02	.01	.12	.08	.04	.03	.02
	Property damage	.10	.07	.04	.03	.02	.14	.09	.05	.03	.02
	Passenger insurance	.31	.20	.10	.07	.05	.99[2]	.66[2]	.33[2]	.22[2]	.16[2]
		$4.16	$2.77	$1.40	$ .94	$ .69	$6.76	$4.51	$2.25	$1.51	$1.12
Total cost per hr of operation		$14.20	$10.89	$7.61	$6.51	$5.93	$16.80	$12.63	$8.46	$7.08	$6.36
Total cost per passenger hr	Passenger hr based on four passengers	$3.55	$2.72	$1.90	$1.63	$1.48	$5.60[3]	$4.21[3]	$2.82[3]	$2.36[3]	$2.12[3]
Total cost per airplane mi.		$ .105	$ .073	$ .051	$ .043	$ .04	$ .112	$ .084	$ .058	$ .047	$ .042
Total cost per passenger mi.	Passenger mi based on 150 mph average speed[1]	$ .024	$ .018	$ .013	$ .011	$ .01	$ .037[4]	$ .028[4]	$ .018[4]	$ .016[4]	$ .014[4]

[1] Includes normal takeoff taxiing and climb; [2] Includes instruction insurance. [3] Three passenger basis; [4] Per revenue passenger-mi.

Lockheed Enters Saturn In Postwar Feederline Race

Company proving speedy 14-place high-wing short hauler featuring payload versatility and design for easy maintenance.

Latest feederliner to take to the air is Lockheed's new all-metal twin-engine Saturn, now undergoing CAA flight tests requisite to obtaining an Approved Type Certificate.

Four major features are stated to mark the new craft—special design for ease of maintenance, extra power through use of jet thrust from engine exhaust gases, use of a low-drag laminar-flow airfoil section, and utilization of a new lightweight aluminum alloy.

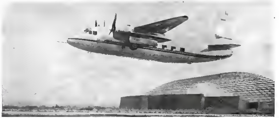
Noteworthy is the Saturn's high wing, which should provide passengers with good visibility. Span is 74 ft., length 51 ft. 6 in., and height 19 ft. 10 in. The cabin is said to be but 34 in. from ground level, and loading and unloading is further facilitated by installation of a retractable tricycle landing gear, with dual main wheels.

Powered by either 800-hp. 7-cyl. Wright Cyclones, or 600-hp 9-cyl. Continentals, fitted with two-blade paddle-type Aeroproducts props, the Saturn is stated to be able to carry 14 passengers or 3,000 lb. of cargo at a cruising speed of over 200 mph. on 60% power. Top speed is over 250 mph. and takeoff distance 1,500 ft. At 16,000-lb. gross weight, climb is 1,325 fpm., and the craft's one-engine ceiling is given as 15,000 ft.

Interchangeability is Highlight

Designed for economical and profitable operations covering smaller communities, Lockheed bore in mind the necessity of the Saturn having to compete successfully with war surplus aircraft. Maintenance features include interchangeability from left to right of main landing gear, landing gear doors, power plants, engine cowlings, elevators, tabs, and wing flap assemblies. The entire nose cone can be swung aside, providing access to all controls and the instrument panel for a mechanic standing on the ground. In addition, the Saturn has a movable cabin bulkhead between passenger and cargo compartments which is said to permit expeditious proportioning of payloads for any given flight. Individual passenger seats are upholstered, hammock-type chairs constructed of tubular steel, and each one is located by a window of generous proportions.

Lockheed started working on the Saturn two-and-a-half years ago, but military commitments delayed completion. Present plans call for export sales as well as domestic marketing. Production schedules are aimed at output of one Saturn daily in 1947.



Good climb (1,325 fpm.) marks new Lockheed Saturn feeder craft, shown on initial takeoff. Seating 14-passengers, tricycle-geared craft is said to have a top speed of over 250 mph.

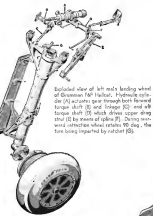
Last-Ditch Jap Warplanes Undergo AAF Scrutiny

Now being evaluated by U. S. technicians for any design advantages that might be used by our industry are craft Nips were readying for action when V-J Day came. Staff photos depict little-known low-speed Lorna, heavily-armed Randy, and long-range Patsy, latest in our last enemy's arsenal.

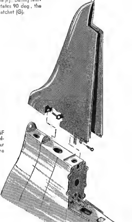
Kyushu Lorna 11 (Q1W1), specifically designed for anti-sub patrol missions, is fitted with special slotted dive brakes of unusually large area. Seating three, craft is powered by two Amakaze 21 (6K28) 9-cyl radials rated at 470 hp. each for takeoff, giving Lorna a top speed of 190 mph. at 4,900 ft and a maximum diving speed of 246. Fitted out for kamikaze missions gross weight was increased from 9,920 lb. to 11 022 lb., including 2,200-lb. bomb load. Construction is entirely metal. Resemblance to Junkers Ju-88 types is very noticeable. ("Aviation" photos)

Kawasaki Randy is a low-wing all-metal two-place craft powered by two 1 500-hp. Mitsubishi radials. Two versions were made: a bomber type (depicted here) armed with one 57 mm. and two 37-mm nose cannon and a 13-mm gun in rear pit plus a bomb load of 1 100 lb. and a fighter fitted with 37 mm cannon and having a ceiling of nearly 50 000 ft. Randy has a span of 51 ft. and length of 37 ft 5 in.

Patsy Ki-74 is one of the most advanced craft Japs were grooming when war ended. Spanning 88 ft 7 in. and having a 57 ft 11 in. length, and a 16 ft, 9 in height, Patsy has a pressurized crew compartment in forward portion of fuselage and was designed to operate at about 40,000 ft. Top speed at 32,808 ft is estimated at 373 mph. with gross weight at 42,769 lb. Range without armor is stated to be 5,000 mi and with armor 4 225 mi.

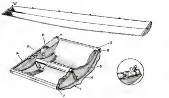


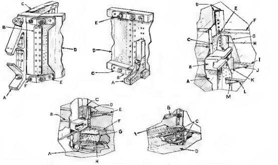
Exploded view of left main landing wheel of Grumman F6F Hellcat. Hydraulic cylinder (A) actuates gear through both forward torque shaft (B) and linkage (C) and aft torque shaft (D) which drives upper drag strut (E) by means of spline (F). During rearward retraction wheel rotates 90 deg., the turn being imparted by ratchet (G).



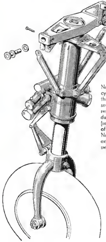
Vertical fin of Grumman F6F can be removed from aft fuselage by removing five bolts; four near the trailing edge and one near the front.

Overall view of Lancaster bombay door is shown at top, with detail sketch revealing construction shown below. End rib is at (A), opening and closing jack attachment is at (B); stiffener at (C); and hinge (D) is shown enlarged in circle at lower right. Sealing strip is at (E); hinge channel at (F); intermediate rib at (G); spar at (H); bomb door outer skin at (I); and edge channel at (J).



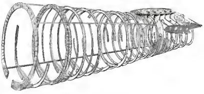


Avro Lancaster spars are built up of trapezium shaped extruded milled booms attached by nickel chrome and steel bolts to flat web alclad plates with sloping shape of booms conforming to top and bottom wing curves. Sketch at upper left shows details, looking aft, of front spar joint at center section and outer panel, with landing gear support beam at (A); web joint plate (B); engine rib (C); outer panel spar web (D); reinforcing plate (E), and steel shackle (F). Top center sketch shows same area, but looking forward, with engine rib at (A); steel shackle (B); reinforcing plate (C); outer panel spar web (D); and boom joint pin (E). Sketch at upper right is joint of top front spar boom to fuselage, with spar web (A); boom (B); web joint plate (C); fuselage formers (D); stringer attachment angle (E); stringer (F); gusset plate (G); shoe plate (H); stringer (I); stringer bracket (J); stringer bracket (K); and stringer and stringer bracket (L) and (M) respectively. Lower left sketch shows lower boom-to-fuselage joint, looking forward, with floor bottom (A); stringer (B); shoe plate (C); gusset plate (D); stringer (E); fuselage longeron (F); longeron bracket (G); and strap plate (H). Lower right is same looking aft, with longeron bracket (A); stringer (B); strap plates (C); and floor top (D).



Nose gear of Ryan FR-1 Fireball retractable tricycle landing gear is designed for greater strength than is customary for land-based planes due to severe forward pitching moments imposed by arrested landings on carriers. Ryan-designed shimmy damper is composed of two hydraulic cylinders (seen above torque scissor) which allow normal turn of 55 deg. but which resist sudden movement. Nose wheel is automatically self-centering when extended by means of cam in oleo and is free swiveling when shock strut is compressed.

Aft fuselage of FR-1 is circular monocoque structure with empennage surfaces so mounted that there is no interference with exhaust from GE I-16 turbojet engine which is mounted in front part in which horizontal cross members can be seen between stringers.



SIMPLIFIED CONSTRUCTION PLUS WEIGHT REDUCTION KEYNOTES NOVEL HIGH-HP. WOOD CONTRA-PROP.

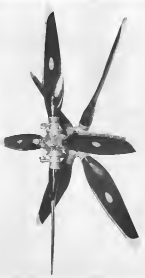


Fig 1 This three-quarter front view of Aeromatic high-hp. 11½-ft propeller shows two 4-bladed laminated-maple plastic-covered units arranged in tandem on coaxial shafts for counter-rotation. Visible on blade flange is bracket and weight for pitch motivation.

DESIGNED FOR A CRAFT powered by a 2,500 hp. engine affording a speed of over 400 mph, Koppers Co, Bartlett Hayward Div's new 11½-ft 8-bladed Aeromatic propeller—two 4-bladed contra-rotating tandem units (Fig 1)—features notable lightweight and simple makeup details.

Hubs used in the dual-rotating assembly consist of a rear unit bored and splined to fit a No. 70 SAE spline shaft, and a front unit splined to fit an SAE 50 shaft extending through the hollow 70 spline shaft. Except for differences in spline shaft size, front and rear hubs are identical. There is no translation member or any connecting link between the two hubs, and the rear hub is fitted with a housing which covers the thrust bearing between the two shafts. Fig 2 is a frontal view of the hub which depicts its general outline and indicates the manner of finishing the original solid chrome-nickel-molybdenum steel billet.

Prop's hub has been bored straight through for each blade socket and also bored through the center for the insertion of spline sleeve welded at the front and rear faces of the hub by atomic hydrogen welding process, thus blending it into the hub structure in as strong a section as though it had been cut from the original billet. A face is machined on each side of the spline sleeve in the center of the blade socket to receive inner journal bearing bosses and a positive stop.

To simplify the structure of the hub shell and provide a simple means of synchronizing the movement of all blades, a boss is machined between each blade socket Fitted with studs, this boss positions a small gear internally between the toothed flanges which retain the blades, thus movement of all blades are synchronized. In addition to showing the synchronizer boss, Fig 3 also depicts the buttress threads, on the inner rim of each blade socket, which receive the blade retaining nut and secure the blade assembly in the hub. No further mechanism is applied to the hub other than the synchronizer gearing, suitable seals, and blade thrust bearing.

Electrical or hydraulic pitch-change mechanism is eliminated. A lag angle is

incorporated in the construction of the blade retaining flange, and each flange is fitted with a counterweight bracket and weight to complete the motivating assembly. Because of the blade lag angle, thrust acts to turn the blades to low-pitch at takeoff and under other conditions when thrust is high. Opposing this aerodynamic moment is the counterweight's centrifugal moment generated by the propeller's rotation tending to rotate the blades to high pitch. At any given forward speed these values of centrifugal force and thrust will position the blades to the correct angle for aerodynamic efficiency and rotational speed. Any change in speed results in a corresponding pitch change because of the forces seeking equilibrium.

Blades are fabricated from 1/16-in. maple laminations bonded under heat and pressure with a thermal-setting resin. To increase stability of the blade blocks, laminations are splayed alternately at 15 deg. to the centerline. After fabrication by profiling machine, the blade is chemically sealed in a ferrule (Fig. 4) and the lag-screw method of blade retention is used to secure it. Applied to the exterior of the blades is a protective coating which is identical to that used on plastic sheeting bonded securely to the wood. This plastic sheeting is pressure-bonded while pliable and hardens to a tough resiliency to provide maximum protection for the wood structure. Finally, stainless steel sheathing is applied over the leading edge. Blade weight is reported to be less than half that of a comparable metal unit.

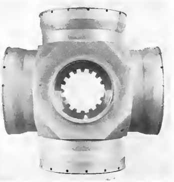


Fig. 2. Front view of hub unit fabricated from chrome-nickel molybdenum steel billet.

Fig. 4. Seen here is 6-in. blade-retaining ferrule.

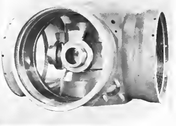
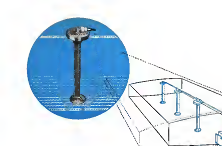


Fig. 3. End view of hub showing blade stop, synchronizer gear boss, and buttress threads.

SHEET NUMBER	D-36
CLASSIFICATION	Materials
SUB CLASSIFICATION	Hardness Scales

Comparative Hardness Tables: Rockwell, Scleroscope, and Brinnell

BRINELL		Rockwell Hardness		SHORE HARD-NESS	BRINELL		Rockwell Hardness		SHORE HARD-NESS
Dia of Impression for 3000 kg Load & 10 mm Ball	Hardness No	C Scale 150 kg 120 Diamond Cone	B Scale 100 kg 1/16" Ball		Dia of Impression for 3000 kg Load & 10 mm Ball	Hardness No	C Scale 150 kg 120 Diamond Cone	B Scale 100 kg 1/16" Ball	
2.20	780	69	* * *	96	3.45	311	32	* * *	43
2.25	745	67	* * *	94	3.50	302	31	* * *	42
2.30	712	65	* * *	92	3.55	293	30	* * *	41
2.35	682	63	* * *	89	3.60	285	29	* * *	40
2.40	653	62	* * *	86	3.65	277	28	* * *	38
2.45	627	60	* * *	84	3.70	269	27	* * *	37
2.50	601	58	* * *	81	3.75	262	26	* * *	36
2.55	578	56	* * *	79	3.80	255	25	* * *	35
2.60	555	55	* * *	75	3.85	248	24	100	34
2.65	534	53	* * *	73	3.90	241	23	99	35
2.70	514	51	* * *	71	3.95	235	22	99	32
2.75	495	50	* * *	68	4.00	229	21	98	32
2.80	477	48	* * *	66	4.05	223	20	97	31
2.85	461	47	* * *	64	4.10	217	18	96	30
2.90	444	46	* * *	62	4.15	212	17	95	30
2.95	429	44	* * *	60	4.20	207	16	95	29
3.00	415	43	* * *	58	4.30	197	14	93	28
3.05	401	42	* * *	56	4.40	187	12	91	27
3.10	388	41	* * *	54	4.50	179	10	89	25
3.15	375	39	* * *	52	4.60	170	8	87	24
3.20	363	38	* * *	51	4.70	163	* * *	85	23
3.25	352	37	* * *	49	4.80	156	* * *	83	23
3.30	341	36	* * *	48	4.90	149	* * *	81	22
3.35	331	35	* * *	46	5.00	143	* * *	79	21
3.40	321	34	* * *	45	5.10	137	* * *	77	20



There's no profit in flying *Unknown Gallons*

THE EDISON LIQUID QUANTITY GAGING SYSTEM tells exactly how much fuel is aboard, at all times, under all conditions. It eliminates the need for carrying unknown gallons of extra fuel. It is equally useful for all other fluids carried, including water.

This system is the simplest, lightest, most accurate means for measuring liquid quantity yet devised. It operates on the capacitance principle, measures mass, rather than volume. Readings are independent of temperature and can be made *accurately*, regardless of altitude or attitude of the airplane.

The heart of the Edison Liquid Quantity Gaging System is a scientifically-designed tank element, as shown above. Each element is tailor-made to suit the exact shape, size, location, and angle of installation of the tank, and the fluid being measured. In addition, Edison designs all tank elements to have the same maximum capacitance, and identical straight-line relationship between capacitance and amount of fluid in the tank.

This means that all transmitters and indicators are completely interchangeable. Thus, in operation of any type of airplane, or fleets made up of several types, maintenance stocks and costs are at a minimum.

This tank-element design, coupled with proper placement in the tank, gives accurate gaging under all conditions. The rest of the Edison system is made up of a simple one-tube transmitter and a moving-magnet ratio gage indicator. The complete system can weigh as little as 5 lbs. per tank, operates on 28 volts with power drain of only 12 watts.

The Edison Liquid Quantity Gaging System can help your planes carry extra payload in safety. For further facts, write for Edison Publication No. 3008. It describes the system, tells how it operates, gives design and installation details. Address Instrument Division, Dept. B, Thomas A. Edison, Incorporated, West Orange, New Jersey.

EDISON

AIRCRAFT SYSTEMS AND INSTRUMENTATION

THERMOMETERS • PRESSURE GAGES
ENGINE GAGES • FIRE DETECTION SYSTEMS
LIQUID QUANTITY GAGING SYSTEMS

By ELTON H. BROWN, JR.
Registered Patent Agent

Following are digests of some of the more interesting patents on aviation developments granted through the U. S. Patent Office. Mr Brown will be happy to answer questions on patents for the reader. Address inquiries to him, care AVIATION, 330 West 42nd St, New York 18, N. Y. Printed copies of any patents listed are obtainable at a cost of 25¢ each, directly from U. S. Patent Office, Washington, D. C.

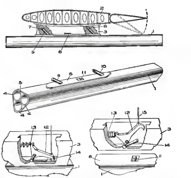
Deicing Mechanism is constructed in form of flexible endless belt passing over rollers in direction parallel to air stream and constituting upper leading edge of wing. Means are provided to brush away ice as it is broken up as result of change in belt contour.—2,399,848, filed Jan. 28, '44, pat. May 7, '46, H. N. Love

Damping Device, intended to prevent shimmy in castering nose- or tail-wheels, employs sliding device controlled by inertia weights to apply friction and obviate shimmy or rotation when weights are out of phase. Free action of wheel is permitted at low speeds when shimmy does not occur.—2,399,732, filed July 24, 43, pat. May 7, '46, J. E. Glover, Jr. assignor to Republic Aviation Corp

Shock Strut is designed to eliminate cantilever bending stresses on the axle, and also cause dragging of wheel, rather than pushing to eliminate tendency to shimmy.—2,399,840, filed July 21, 44 pat. May 7, '46, F. E. Bachman, assignor to American Steel Foundries.

Hydroplane Device, pivoted on lower portion of flying boat stern, has downwardly curved tail balanced to strike water on landing and tilt so as to change angle of flying boat and also function as brake. Also applicable for takeoff, device is controlled manually or automatically.—2,400,173 filed Oct. 28, 41, pat. May 14, 46 T. B. Slate

Aerodynamic Brake comprises series of rubber rings circumferentially positioned on fuselage and containing tubes which may be inflated to force ring into drag creating contour.—2,400,388 filed Mar. 17 '44 pat. May 14 '46, R. G. Campbell assignor to B. F. Goodrich Co



Rocket Firing Tube, consisting of cluster of plywood elements, is adapted for attachment to wing undersurface and to be jettisoned, after rockets are fired, so as to fall downwardly and rearwardly to prevent damage to wing structure. As shown in accompanying illustrations tube cluster (1) is attached to wing (2) via wood or plastic mounting structure (3) having streamlined planform. Cluster consists of three plywood tubes (4) bonded into unitary structure by wrapping (5) carrying mounting plate (6). Mounting structure (3) has holes (7) and (8) directly running downward and to rear for receiving pins (9) and (10) attached to cluster mounting plate. Rear pin (10) is fitted with multi-pronged plug cooperating with socket to provide electrical circuits for firing tubes. Plate pin (11) is engaged by hook (12) normally held in latched position by spring (13) and handle (14) extends outside of mounting structure (3) to afford means of holding hook in unlatched position until tube cluster is in place. Cable (15) allows for release of cluster by actuation from within fuselage.—2,398,871, filed Apr. 20, 43 pat. Apr. 23, 46, W. J. Turnbull and W. Buebal assignors to Glenn L. Martin.

Recent Books

A HANDBOOK OF INTERNATIONAL TRADE, Available from Committee for Economic Development, New York City 100 pages, 50c.

Part I of this booklet deals with export for the manufacturer while Part II considers import for the manufacturer, wholesale distributor, and retailer. Each of these two parts is treated in a succession of detailed steps. For anyone considering international trade, or for those already in it, the book contains a host of valuable information.

RECENT AERONAUTICAL LITERATURE, compiled and edited by Willard K. Dennis, Librarian, Beech Aircraft Corp., Wichita, Kan. 387 pages. $5.00.

Beech Aircraft has performed a special service in indexing more than 15,000 articles from U. S., Canadian, and British aviation periodicals and related trade journals. This edition, sub-titled *Selective Subject Index for 1945* is of definite utility to any sizable library and to individuals working constantly with aeronautical literature. It is supplemented by a monthly service which for 1946, costs $5.00

STATICALLY INDETERMINATE STRUCTURES, by Lawrence C. Maugh. John Wiley & Sons, New York City. 338 pages. $5.00

Practicing engineers will be much interested in Dr. Maugh's comprehensive treatment of continuous frames, trusses, bents, and frames with curved members by the method of moment distribution. If the engineer is engaged in aeronautical work he will be especially attracted by the material on fuselage frames, space structures, and stresses in thin walled sections.

AIR-VU SYSTEM OF DRAWING by Daniel J. McQuaid. The Air-Vu Co., Denver, Colo. 218 pages, illustrated.

Principal object of this book is to explain the principles of the Air-Vu system of drawing or delineation, and it teaches how to employ these principles in the drafting room. Not limited to any single type of work, the author's system is stated to be applicable in any field. Emphasis is given to the making of three dimensional engineering and architectural drawings, catalog illustrations, exploded views and visual education work.

INDUSTRY PUBLICATIONS

Detailed study of N. Y. C.'s economic and social prospects including aviation field, has been issued by Bankers Trust Co. of N. Y., 16 Wall St. ... "Air Harbors—Ready Made Airports", is attractively illustrated booklet available from Edo Aircraft Corp., College Pt., L. I., N. Y., outlining basic requirements and steps in establishing float-plane bases ... "London-N. Y.", is BOAC's glossy booklet outlining Britain's trans-Atlantic operations.

Technical Bulletin 102 from American Road Builders Assn., 1319 F. St., NW, Washington 4, D. C., contains articles dealing with design and building of modern airfields ... "Gyroscope Through the Ages", is comprehensive pamphlet dealing with origin and history of gyroscope. It's available from Sperry Gyroscope Co., Great Neck, N. Y. ... "Memo for Airminded Executives", available from Bankers National Life Insurance Co., Montclair, N. J., is handsome slide-in-case book containing a non-technical study by Gill Robb Wilson on life insurance restrictions on executive travel via company-owned planes.

LUCUBRIOUS LOUIE was feeling most nostalgic. "Time was," he lamented, "when this business was *flying*—something apart, something with peerless individuality, exalted above the commonplace, something with a cold beauty untrammeled by . . ."

We interrupted to find the cause of this nostalgic outpouring. Turned out to be a clipping from the morning press announcing appointment, by one of the airlines, of a motion-picture manager.

• In our June issue, Old Man Side Slips reported almost being in the airport business as the result of a catalog listing surplus "Airports, new, good condition, $30 each, in lots of 25-50, $12 each." When he discovered it to be a nautical catalog, Old Man SS said "Wish to goodness those sailors would learn to call a porthole a porthole." Quick as a PT boat he got a sizzling letter from the associate editor of a seagoing magazine as follows:

"Of all the cocky and cock-eyed comments oozing out of a brash and bumptious brain, this one tops the list. For your information, dear boy, and as a belated contribution to your lack of learning, be informed that the ancient and honorable word 'airport'—in the sense in which you deplore it—was being used by men of the sea long, long, before Wilbur and Orville Wright (whoever they were) had achieved the status of swaddling clothes. In flagrant violation of the vested rights of the marine fraternity, you grease monkeys absorb the word for your own twisted uses—and now you whine that sailors use it in lieu of the corny word 'porthole'.

"Continuing my gratuitous contribution to your education, 'porthole' is one of those landsman's terms, used by the miserable folk who dribble about a ship's 'prow'. No honest marine man (if there are such) would permit the word 'prow' to stir on his lips. It is akin to such poetic terms as the 'plashing' of a waterfall in a woodland glen."

Oh guardian of Fraternity Neptunus
We thank thee for correcting us,
So here and now we take a vow
To use naught else but bow.

But, chum, we'll stick to that word 'airport,'
No matter how derisively you may snort,
For Webster's Collegiate 1942, fifth edition,
Ignores completely your musty definition.

And the Columbia Encyclopedia
With which you're no doubt familia,
Has a lengthy airport dissertation
With nary a single nautical connotation.

So could it be, thou ancient with salty crust,
That on progressive knowledge thy bow has bust?

• Blaine Stubblefield of our Washington staff recently returned from a flying vacation—a sort of busman's holiday—and reports as follows: "Had a marvelous time in the west. Among other things, went down in Snake River canyon in a Piper Cub and found my old homestead, also my uncles. Crossed the Blue Mountains in another one, with 100 ft between overcast and treetops. Looked straight down a cliff 3,700 ft high—in Yosemite Park; saw a tree 3,900 years old (it's really thirty-eight hundred, but the eight is gone from this typer); waded a river that was 37 deg. above zero, winning one dollar and charley horses in both legs; rode an automobile through San Joaquin Valley at 105 F.; was snowed on in the Wallowa Valley of Oregon; penetrated a 200-mi. thunder squall with one of my favorite airlines, surrounded by five passengers upchucking, and saw one stewardess who had to seek oxygen all the time while the other one did all the work. That completes my report."

And, we hope, that'll teach Stubb to stay out of automobiles and away from cliffs.

"Even a heat-seeker missile can't make Maguire give up his stogies."

THE AVIATION NEWS

ELAINE STUBBLEFIELD, Washington — HERB POWELL, New York — E. J. BULBAN, New York

Bikini Drop Achieves Experts' Expectations; Senate Allows CAA Repairs in Budget Boost

. . . Air shows body formed . . . More big fields seen in airport act amendment . . . CAB probes Constellations, XB-42 design cleared . . . Compile 'copter criteria.

Results of "Able Day" at Bikini were all that conservative experts expected, but optimistic advance billing by Army and Navy press agents resulted in public disappointment which will play directly into the hands of mossback militarists resisting the progress of aviation.

Many observers believe that U S prestige has been damaged by the big show, with representatives of many other countries in ringside seats Secret progressive testing of atomic warheads for all types of missiles would have served the country's interests much better, in their opinion. Such tests would have helped to establish the true balance between air and sea power—information of high value in the country's safety

As it is, unification of the armed services much desired by the AAF, will be further obstructed by the battleship admirals, who will also use every means to win support of their hierarchy at the expense of aviation and flying missiles Even the potentialities of nuclear explosives against land forces and installations has been in some degree discredited.

Vice Adm. Wm. H. P. Blandy, commander of Operation Crossroads, and his entire staff, are aclaimed in all quarters for the precision, thoroughness, and safety with which they did the job Their careful and skillful arrangement seems to have yielded all information possible in one test, and more will be coming for weeks and months.

It was the public who approved the big-top act instead of a quiet intensive research program Plenty of people think the public was wrong, and more may think so in the future.

Senate Allows CAA Repairs in Budget Boost

Senate Appropriations Committee, acting on Commerce Department's 1947 budget approved a total for CAA of $129 671 302 or nearly twice the $86,210,582 which had been allowed by the House. Largest item added by the Senate Committee was $55,000 000 for airport development. CAB receives $2,332,000. CAA tentatively won its battle with air service industries over its plan to procure war-surplus parts and maintain its own fleet of 231 war-surplus airplanes The Senate committee restored the $300 000 cut by the House from funds for the purpose and wrote in an authorization for CAA to do most of its own repairs

Air Shows Body Formed

A non-profit organization, called National Aircraft Shows, backed by U S aviation industry and the armed services has been set up to produce two comprehensive official aviation shows yearly as a means of demonstrating aviation's strides to the American public (See Coming Up for first show). Located in Rm 7318, Empire State Bldg, 350 Fifth Ave., N Y C, the new body has cooperation and sanction of Army, Navy, Marines CAA, NACA NAA, Air Force Assn., Air Power League, NATA ADMA, ATA, and AIA. It's stated that a joint committee composed of above groups will also screen, sanction, and aid other worthy exhibitions Leon Shloss recently resigned his position as pres. of Aviation Writers Assn to become NAS public relations director

More Big Fields Seen in Airport Act Amendment

A bill before Congress would amend the new billion-dollar federal airport act so that part of the money could be spent on construction of class 4 and 5 airports Main objective of the act was to provide small fields for the stimulation of private and feederline aviation. It was thought that Army, Navy and CAA war-built surplus fields would meet all requirements for air transport. But it was found later that more big fields would be needed. The amendment had passed the House at this writing

CAB Probes Constellation; XB-42 Design Cleared

International airline service was badly, though briefly, interrupted by sudden CAB order grounding all Lockheed Constellations for 30 days following crash by a TWA training craft Pres Robert E Gross immediately issued the following statement 'In conjunction with CAB, Constellation airplanes have temporarily been withdrawn from service following an airplane crash which occurred during a routine crew training flight at Reading Pa on July 11 This company is now conducting an investigation into the cause of the accident in full cooperation with CAB" On withdrawal of "Connies", most airlines immediately revamped schedules around DC-4s and soon had services nearly back to normal BOAC, expecting less than 30-day grounding, made no substitutions

Shortly afterward, AAF announced no evidence of structural failure or inherent flaw in design had been found as result of investigation into crash of Douglas XB-42 Mixmaster last December Air-

★ COMING UP ★

July 12-Aug 11 Centorama Aviation Show, Milwaukee, Wis

Aug 1-2 National Flying Farmers Assn First Annual Convention & Oklahoma Flying Farmers Conference, Oklahoma A&M College, Stillwater, Okla

Aug 3-18 First Postwar Annual Soaring Contest, Harris Hill, Elmira, N Y

Aug 15-16 IAS Annual Summer Meeting Los Angeles

Aug 15-18 New England Air Show, sponsored by Aero Assn of Boston, Bedford Airfield Mass

Aug 17-18 Port Columbus Air Show, Ohio

Aug 21-28 First World Congress on Air Age Education International House, N Y C

Aug 22-24: SAE National West Coast Transportation & Maintenance Meeting, New Washington Hotel, Seattle

Aug 30-Sept 2 National Air Races Cleveland

Aug 30-Sept. 2 National Championship Model Airplane Contest Wichita Kan

Aug 30-Sept. 7 First Postwar Canadian Air Show sponsored by NAA of Canada, DeHavilland Airport, Toronto

Sept. 4-12: Air Fair sponsored by Aviation Council of Metropolitan St Louis

Sept 8-15 St Louis, Mo, Aviation Week

Oct 3-5 SAE National Aero Meeting & Aircraft Engineering Display Biltmore Hotel Los Angeles

Oct 14-17 National Aviation Clinic Oklahoma City

Oct 16-17 SAE National Transportation & Maintenance Meeting, Hotel Knickerbocker Chicago.

Oct 23-25 Second Annual Arizona Aviation Conference, Phoenix, Ariz.

Oct. 24 IAS Air Transport Meeting Statler Hotel, Washington, D C

Nov. 7-8 SAE National Fuels & Lubricants Meeting Mayo Hotel Tulsa, Okla.

Nov 15-24 National Aircraft Show sponsored by AIA, former Fisher Bomber Plant, Cleveland

Nov. (Exact date unannounced) International Aero Exhibition, Paris, France

Dec. 2-4 SAE National Air Transport Engineering Meeting Edgewater Beach Hotel Chicago

Dec. 17 IAS Wright Brothers Lecture N. Y. C.

ILL FATED XF-11 PHOTO RECON

Taken shortly before its first and disastrous, test flight, this photo shows details of Howard Hughes XF-11 photo reconnaissance plane in which he crashed. Craft was designed to do over 400 mph. with ceiling of more than 40,000 ft.

frame and power plants were exonerated by Army's Examining Board, which added it "could not eliminate possibility of 'fuel starvation' as a contributing factor."

Compile 'Copter Criteria

CAA's proposed Rotorcraft Airworthiness Regulations Part 06, now being circulated for suggestions are the first government compendium of helicopter design criteria in the world Airworthiness Requirements Committee of AIA will receive suggestions and make further recommendations to CAA, covering flight requirements, strength design detail, power, equipment etc.

Plane Atom-Power Contract Awarded to Fairchild

The task of coordinating research for developing nuclear energy for aircraft power plants has been awarded Fairchild under a primary contract from the AAF

Complete or even partial success in this enterprise may well change the future of the aircraft industry It's said that Fairchild has been conducting preliminary investigations for months, and enough has been learned, according to AAF sources, to indicate that eventual solution of the complex problems is not impractical. While Fairchild has been charged with the basic responsibility for fostering the atomic engines project and will administer and coordinate its various aspects the company will not work alone.

Unusually close collaboration with a large number of other concerns the AAF, and the Manhattan District Project, will prevail and the general knowledge gained is to be shared with the entire aircraft engine industry.

Fairchild has started the task of assembling an organization for the basic work, but it's stated that no permanent site has yet been picked, although negotiations are underway.

CAA Announces Title Fees

CAA announced that it has inaugurated a $5 charge for registration and recordation of all aircraft titles in accordance with the Congressional mandate to defray the cost of CAA's service operations through fees wherever possible. Another charge of $10 for air agency certificates is now being approved by a Congressional subcommittee in charge of CAA appropriations This would cover flying and ground schools, and mechanic and repair stations. A fee of $5 will be asked for the issuance of certificates to parachute lofts.

Where liens, chattel mortgages and other encumbrances on the title of an aircraft are involved in its recordation, there is to be an additional $5 fee, which it is said would defray the cost of the satisfaction of release of such liens

The title charges followed a meeting of CAA officials with J T Geuting, Jr and Don Mockler, AIA, L Swenson and J McKee NAA J B Hartranft, Jr. AOPA W Weishaar, ATS; and J Batchelor, UPMA.

* SPOT CHECKING *

Air research demonstration was recently staged by GE during dedication of new test lab at Schenectady Airport N Y. Following tour of company's flight research facilities an air show was staged in which latest personal and Army-Navy combat and transport craft participated Highlights included first jet airmail flights, using P-80As Also shown were little-known Boeing XB-29E fitted with retractable GE TG-180 turbo-jet engine, Convair XB-24P with jet unit in fuselage, and Convair XB-24Q fitted with radar gun-directing devices

First flight training school for civilian 'copter pilots has been started by Bell. Course to extend 6-8 wk. has as one of its students, Stephen W O'Donnell, Post Office airmail aide, who will obtain technical knowledge in preparation for airmail shuttle services scheduled to start soon.

Luminous chart which can be read using ultra-violet black light has been developed by two NATS pilots to overcome hazard of reading maps by means of flashlight or cockpit lights. Now in use by NATS process involves photographing standard chart then exposing picture on sensitized carbon tissue film which in turn is pressed into a silk screen. Lacquer is then sprayed around chart's pattern and varnish is screened through pattern Finally wet pattern is brushed with luminous powder. Chart is equally legible in daylight

Prices of surplus L and K type airships have been scaled down 50% by WAA, with former now at $2,000 each and latter at $5,000.

Improvement of cockpit design to insure greater safety during crackups is purpose of $1,000 contribution by AOPA for research into personal aircraft injuries which is to be conducted by Hugh de Haven of Cornell University Medical College. Problems under investigation include airframe collapse characteristics study of head injuries feasibility of crash padding, and precise worth of safety belt webbings and attachments

Navy activated Reserve Air Program and opened 13 Naval Reserve Bases and 7 Reserve Air Units throughout U S Fixed with responsibility of training Reserve Air Groups that will be identical in composition and strength with regular Navy air groups comprehensive program using latest equipment and tactics is underway. At Floyd Bennett Field N Y for example program calls for training of 18 combat and 3 transport squadrons and 1 large carrier air support unit (engineering and maintenance) In addition, a Voluntary (Standby) Reserve of unlimited size is to be indoctrinated.

Converted Douglas C-47 flying lab has been placed in operation by Minneapolis Honeywell Plane is equiped with electronic instruments designed to measure and record over 1,000 different flight functions.

NEWEST PASSENGER CARGO 'COPTER

Artist's drawing of Kellett passenger-or-cargo helicopter designed for low cost short haul work. A twin engine craft featuring dual rotors developed in Kellett XR-8 military craft this new commercial carrier has accommodations for crew of two plus ten passengers and baggage.

UAL is distributing gratis to women patrons 100,000 lipstick license booklets bearing on cover advertisement of airline's transportation facilities Handy beauty aid is made by Diamond Match Co.

Airborne facsimile, sponsored by PCA and Finch Telecommunications was recently demonstrated aloft in a DC-4 Capable of printing a four-column newspaper at 500 words-per-minute rate, equipment is being tested as possible airline passenger service. Transmission includes photographic reproductions.

Among AAF's latest seeker missiles are GB-5 light seeing glide bomb, which is a high-wing twin-boom glider with egg-shaped nacelle housing target-seeking apparatus also GB-6 infra-red heat seeker missile and in addition a radar-seeker type.

Republic boosted price for standard Seabee from $3,995 to $4,495 FAF noting increase was necessitated by rising costs in equipment, parts and tooling. It's said that initially delivered craft will be fitted with Hartzell reversible controllable-pitch props listed at $350 extra. Seabee deliveries have now got underway, following recent receipt of ATC for craft.

* PLANES AT WORK *

Aviation dept of Statesman Newspapers Boise Ida., purchased Convair BT-13B for use on special news gathering assignments.

Piper inaugurated own air freight service using Cubs, to expedite delivery service of critically needed items

First aerial mass shipment of cattle was made by Commander Line DC-3 when ten pure bred calves (first of 300) were flown from N J to Colombia, South America. Flight took but 30 hr as compared with 30 days for water shipment

Unique delivery service is in operation among islands of western Lake Erie where American Stove Co is distributing Magic Chef gas ranges via Ford Tri

CONVAIR GROOMS "BIGGEST AND RANGIEST"

First photo released of Consolidated Vultee XB-36 "10 000 mi. bomber" It is powered by six 3 000 hp Pratt & Whitney Wasp Majors turning pusher propellers world's largest land based bomber as it started tests. Wing span is 230 ft and length 163 ft. Listed as (Press Assn photo)

motor cargo plane operated by Port Clinton-to-Island Air Service

To facilitate communications in construction business, F. H. McGraw & Co., Hartford, Conn., has purchased Beech 18 for travel between various building projects.

A planeload of 150 HomEase household oil burners was recently flown from N.Y.C. to Seattle via California Eastern Airways DC-4. Burners were urgently needed to complete unfinished homes.

Aerial photos of horse races at Rockingham Park, Salem, N.H., are to be taken by 'copter. It's stated pictures will be ready for processing before each race is over.

Air shipment of personal plane floats has been started by Edo after concern discovered that flying rates were only slightly higher than express and crating could be considerably simplified.

Load of 300 auto tires was flown from U.S. Rubber's Wis. plant to Iowa via Slick Fresh Air Freight DC-3.

Shipment of 8,366 lb. of uncrated furniture was recently made by Slick Airways Curtiss C-46 from Chicago to San Francisco at charge said to be only 30% more than van charges and with savings on crating and storage.

Air shipment of 66,000 hatching eggs was made to Prague, Czechoslovakia, under UNRRA auspices, via Veterans' Airlines Douglas DC-4.

Completely stocked with emergency drug supplies anti-toxins, rescue and aid equipment, and a pistol "Jung", a new Bell Model 47 helicopter is to be put in operation in Southern Calif. as a mercy ship by United-Rexall Drug Co. Craft is to be stationed on roof of firm's recently completed Los Angeles hq.

★ OBITUARY ★

Fritz Koolhoven, 60, famed Netherlands plane manufacturer and designer. Head of N. V. Koolhoven Vliegtuigen, Rotterdam, he got exhibition pilot's license in 1910 and is credited with designing and building first Dutch plane. Also associated with Deperdussin, Armstrong Whitworth and B. A. T. By '38 his factory employed over 600 persons. He was a member of French Legion of Honor, also a Fellow of British Royal Aero Society.

★ CALLING NAMES ★

T. Rieber has been elected a director of TACA.

James C. Welsch has been named N.Y. distributor for Cessna.

Dudley Steele has been appointed PCA airport consultant and will be in charge of Willow Run Airport.

NAA Conn. Chapter elections: **Francis S. Murphy,** chairman; **Thomas H. Lockhart,** director of oers.; **Kenneth H. Ringrose,** asst. director. Members are: **Eugene E. Wilson, Brig. Gen. R. B. DeLacour, Sen. Edward P. Egan,** and **Maj. D. F. Wheeler.**

Millard S. Davis has been named pres. of Georgia Aviation Trades Assn.

Robert W. Prescott, pres. of National Skyway Freight, has been named pres. of Independent Airfreight Assn. **Earl F. Slick** and **Harry R. Playford** were made trustees.

Rufus C. Phillips, pres. Airways Engineering Consultants, has been appointed chairman of Airport Committee of Aero Club of Washington.

Samuel B. Mosher has been named chairman of board of directors of National Skyway Freight.

Norseman Air Transport appointments: **Arthur Byam** has been made chief of personnel, **Hans S. Mueller** has been appointed v-p. in charge of operations with **Robert Demerest** as asst., and **John H. Hotson** has been named regional director of Canadian operations.

Charles L. Lathrem, propeller engineer, has joined engineering staff of Aircooled Motors.

George C. Ford has been appointed div. mgr. for Convair's Vultee Field div., with hq. in Downey, Cal.

Fairchild directors: **Sherman M. Fairchild, J. Ford Johnson, Jr., Webb Wilson, J. A. Allis, Myron F. Gorden, Roswell H. Rausch, William B. Scarborough, J. Carlton Ward, Jr., H. Harold Eudes,** and **Richard S. Boutelle.**

Hardy K. Maclay has been appointed asst. gen. counsel, Finance Legal Div. of CAB.

Walter G. Hawkins, pres. of Air-Parts, Cal., has been elected v-p. of ADMA.

LOOK, BUT DON'T LAND—YET

Near New York City's huge Idlewild Airport, Commonwealth Skyranger, just off production line at nearby factory, makes "reconnaissance" lap. Originally slated to open early this fall, sky terminal has been beset by labor and supply difficulties; now faces further delay as newly appointed Airport Authority studies complete revision of plans, including revamping of passenger handling facilities and non-aviation revenue sources. (Martin & Kelman photo)

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Once again the Sea-Air Committee, fighting for CAB certification of maritime companies to operate auxiliary airlines, gets a setback. President Truman, following FDR's policy, tells Congressmen he flatly opposes ship-line participation in air transport. In retaliation, sea-line men will support McCarran's defunct "American Flagline" chosen-instrument bill. It's a fair guess the steamshippers can't win that way, but they might some other way, some time.

The Stubblefield Award is designated to U. S. Customs. The collector at New York City charged the Burgomeister of Amsterdam $3 duty on the frame of an oil painting, sent via KLM's first trans-Atlantic flight to the Mayor of New York.

Question now arises whether immense cost of supersonic wind tunnels will be justified. Airfoils and shapes are being tested in high speed currents flowing around wings of planes in flight, also in free falls from high altitudes. Glenn Martin, Caltech, Army and Navy Ordnance, and others, are doing the non-tunnel experiments. Results may affect plans of NACA, Army, and Navy to set up a huge air research center, whose tunnels would require prodigious horsepower.

Army-Navy tussle over testing of the obsolete German V-2 rockets has been eased temporarily by creation of a joint rocket panel, including civilian interests. Firings are scheduled and allocated, with all parties participating in resulting data. But the big fight will come later, between air forces and ordnance bureaus of both services, who got the jump and are far ahead.

At first quite unconcerned, airlines are now worried about the competitive ability of non-scheduled and other newcomers getting in on air transport. The would-be's have few expensive vice-presidents, research, engineering, legal, and other departments, and few high-rent offices downtown. A well-financed group recently offered to carry air parcel post at half the rates for air express. CAB and scheduled operators were figuring most of them would go broke quick, but they're not sure.

At every turn, Navy has successfully blocked unification of the armed forces and creation of a co-equal air force—and there will be no decision by this session of Congress. Even if the President's plan got consideration, it would then be torn down to a wishy-washy compromise. Chances of a real re-organization are dwindling with the waning of public interest in military matters.

Frederick H. Lee, Jr. has been appointed sales mgr. of Aviation Products Div. of R. M. Hollingshead Corp.

Samuel F. Baker has been named pres. of United Aircraft Products.

Lt. Col. James L. McCoy, former head of flight test instrumentation section of Wright Field, has joined Revere Corp. of America.

J. J. Medaries and **Charles P. Knecht** have been appointed assistants to v-p., traffic, for Delta Air Lines.

Thomas H. Leckett has been named v-p. of Braniff International Airways.

Jesse W. Sweetser, former C-W public relations director, formed his own company, Sweetser Corp., 41 E. 42d St., N.Y.C., which plans to develop and market products of wartime research for commercial use.

W. J. Kane has been appointed West Coast rep. for SILA, Swedish airline.

Aviation Section, N. Y. Board of Trade named following to executive board: **W. L. Baker, George Bauer, John F. Budd, Gen. J. Carr, J. Burleigh Cheney, C. De Groot, Charles E. Daugherty, Richard E. Fell, Maj. Robert Fogg, James Graham, H. J. Lyall, Bowman Otto, C. S. Robinson.**

Industry Lists Research Center Conditions; Lapse of Science Foundation Measure Likely

. . . Release sweepback data . . . See cut in prop noise: propose lightplane aids . . . May military output 170: Army 89, Navy 81 . . . Jet engine competition up.

Position of the aircraft industry regarding proposed super research center is set forth in a statement by the Aircraft Industries Association to Dr. George W. Lewis, director of research, NACA, and to Maj Gen Curtis Lemay, director of AAF's research and development

The industry will support the research program, says AIA, so long as it conforms to the policy set forth last March.

Industry to handle airframes, power plants, propellers, when financially possible, in non-government facilities; facilities staffed and operated by the government must be available to industry under same conditions as prevail in privately operated facilities; industry's development tests in government facilities must be scheduled in accordance with industry's requirements; in decisions on concentration or dispersion, it is recommended that strategic location and proximity to related facilities be taken into account.

Despite repeated expressions by high military air authority that strong research programs are urgently needed now, the fiscal 1947 budget for the Office of Scientific Research and Development was cut to $97,000 from $70,000,000 in 1946.

Meanwhile the Kilgore-Magnuson bill to establish a National Science Foundation seems likely to die with the present Congress. The Senate, already burdened with other pressing matters, is not inclined to face controversy lurking in the bill's patent provisions. A similar bill by Rep Wilbur Mills (D Ark.) was introduced and hearings were started and discontinued, subject to recall by the House Interstate and Foreign Commerce Committee.

Release Sweepback Data

Wartime research data on sweptback wings, released by NACA, indicate that 45 deg sweepback is needed for transonic speed, and 72.5 deg for speeds over 2,000 mph. Structural problems will necessitate short stubby wings with 55 deg the maximum sweepback for rectangular wings and 65 deg maximum for pointed wings. Rudders and elevators seem destined to disappear, leading to the all-wing design for stability. Sweepback will require greater longitudinal stability by the use of 40% more vertical fin area for a sweepback of 45 deg.

Very high landing speeds appear inevitable, with high sinking speed in glides requiring high pilot skill. Flaps are less effective with additional sweep, and other devices will have to be used. Ailerons become increasingly ineffective, indicating decreasing maneuverability for fighters.

See Cut in Prop Noise; Propose Lightplane Aids

Propeller noise may be reduced as much as 60% by the use of as many as 8 blades operating at low speed, in the opinion of Dr Theodore Theodorsen, of NACA's Langley Field laboratory. He said a 50% reduction could be foreseen in the very near future and multiple blades is the only means in view for reducing propeller noise. Grover Loening, NACA consultant, recommended the use of war-developed catapault and arresting gear in light plane operations. The men were addressing Institute of Aeronautical Sciences.

May Military Ontput 170; Army 89—Nevy 81

AAF and Naval plane acceptances in May increased to 170 compared to April's 148. AAF's 89 planes were 21 B-29A, 17 P-80A, 8 C-82 and 43 PQ-14A. Navy got 2 PBM-5E, 2 XBT2C-1, 14 F7F-3N, 21 F4U-4C, 33 F8F-1C, 7 F8F-1C and 2 JRM-1. May airframe weight was 1,881,300 lb. compared with April's 1,503,300 lb.

Jet Engine Competition Up

A dozen or more companies are in or nearing production of jet engines in this country. Leaders among them are: GE, Westinghouse, Pratt & Whitney, Wright, and Allison. The latter is the only one in volume production—for Lockheed P-80s. Others in the field are Northrop-Hendy, Monasco, Aerojet, Frederic Flader, De Laval Steam Turbine, G. M. Giannini. Taylor Turbine Corp has been licensed to manufacture the British Rolls-Royce Nene and Derwent jet engines.

IT'S THE CHUM, CHUM

First photo of Aeronca Chum, two-place spin-proof two control craft slated for production later this year by the well known personal plane manufacturer. Chum has metal fuselage fabric-covered metal cantilever wing, and tricycle landing gear. With 85 hp Continental engine, top speed is listed at 120 mph, and cruising speed 108.

* INDUSTRY MEMOS *

Martin received orders for 84 additional Model 202 and 303 airliners, including 14 for South American operators.

Fairchild announced licensing of Duramold plastic molding patents to Brito Pereira & Co. of Rio de Janeiro.

Franklin received orders for 1,000 additional 4-cyl model engines for Stinson 150 personal planes.

Socony Vacuum nationally standardized its aviation gasolines. Company is marketing Mobilgas 80 oct. and 100 stated to cover all commercial and personal plane needs.

Convair signed $1,380,000 contract with PAA for 20 Model 240 airliners with deliveries scheduled for next Summer. Company also received AAF order for unspecified number of F-81 prop jet plus-jet fighter craft.

Aeromatic's 1946 orders for three-prop models is said to have exceeded $1,000,000. Company reports its airscrews are standard on Globe Swifts, Reliance Cruisairs, NAA Navions, Johnson Rockets, and Republic Seabees.

Texaco reveals development, in conjunction with Navy, of synthetic fuel, also lubricants for experimental gas turbine and turbo-jet engines.

* FOR THE RECORD *

Air-Parts, Glendale, Cal., opened a completely stocked air-conditioned aero supplies building at Sky Harbor Airport, Phoenix, Ariz.

Aredis Engineering Corp., 3107 Maryland Ave., Baltimore 18, Md., has been newly organized to exploit Aredis System of landing and launching aircraft from suspended cable runways.

Aviation Maintenance Corp., Van Nuys, Cal., is new concern using former Navy-Lockheed modification center for airlines and private plane overhaul work.

Lockheed plans to spend about $750,000 in establishing eastern service base for Lockheed Constellations at McArthur Field, L. I., N. Y.

Aircraft Mechanics, Inc., Colorado Springs, Colo., have been appointed prime manufacturing source for Douglas-designed servicing equipment.

Taylorcraft purchased Cleveland plant of Detroit Aircraft for manufacture of various subassemblies.

Jenke & Co., 325 E. 44th St., N. Y. C., is newly formed concern that assumes control and continues operation of engine test div. of Jacobson & Co., maker of aviation test equipment.

Dansaire Aircraft Corp. is new name for Faircraft Corp., Dansville, N. Y., maker of new personal plane.

New arrangement between Western Gear Works and Pacific Gear & Tool has been made with Cone-Drive Div. of Michigan Tool Co. to make available on West Coast the Cone-Drive aviation equipment.

Allison set up a new div. devoted exclusively to development and production of bearings known as Allison Bearing Plant. Location is Main St. in Speedway, Indianapolis.

Fairchild is moving its personal planes division from Dallas to former Army plant at Strother Field between Winfield and Arkansas City, Kan.

Non-Scheduled Carriers Battle CAB Rule; Charge Airlines With Exorbitant Mail Rates

. . . New feeder routes awarded . . . Senate moves to ratify Chicago convention . . . Overseas routes show sharp gain . . . East Coast route case brings ethics charges

The Institute of Air Transportation representing scores of non-scheduled air operators mostly war veterans using war surplus airplanes, has charged that the certificated airlines hold a monopoly in their field, attacked proposed non-schedule control by CAB, and asked Congress to investigate and possibly cancel airmail contracts so that non-scheduled operators, who prefer to be called "fixed base" operators, can participate in mail transport.

IAT, which presently represents more than 70 fixed base companies, also asks that, pending Congressional hearings, its members be permitted contract with rail and steamship lines for carriage of mail, passengers, and cargo. Thus IAT at least wins the moral support of a group strongly opposed to the regular airlines.

IAT's resolution, submitted by its president, Lawrence J. Carr to CAB, to Congress, to Mr. Truman, and other federal agencies, suggested that fixed base carriers be allowed 20 round trips per month or 500 hr flight whichever is greater, carrying passengers between any two points served by scheduled airlines with no restrictions on cargo except those relating to fair competition.

CAB recently issued a definition of non-scheduled service, and proposed an amendment to its old exemption order (which for years has suspended economic control of fixed-base operations) limiting flights between two points to 10 per mo. Operators making more than 10 flights would be required to apply for certificates which of course might be denied.

IAT's resolution also stated: That existing airline certificates do not authorize carriage of freight as such, that airlines are receiving exorbitant rates for carrying mail and that fixed-base operators could carry letters for 3¢ at a profit, that air parcel post service should be carried immediately by fixed-base services, that CAB's proposed amendment to the exemption order will prohibit promotion of business by fixed-base operators and force them to close down. Scheduled airlines are preparing to defend their position.

CAB Certificates Feeders

Acting under the government's established policy of expanding local aviation services, CAB is rapidly certificating new operators. The seventh feeder carrier to be awarded routes was E. W. Wiggins Airways, a pioneer fixed base operator since 1930 at Norwood, Mass., to serve six northeast and New England states.

In this fourth of 11 scheduled regional proceedings, CAB ruled out four proposed helicopter services declaring available equipment does not have capacity to do the intended job.

CAB examiners R. I. Newman and C. C. Henderson have recommended certification of nine operators in a vast extension of services covering 14 southeastern states. Five trunk air systems would participate in this award if CAB approves it. Zimmerly's Empire Air lines recently certificated in Idaho, Oregon, and Washington will be among the first feeder systems trying to demonstrate feasibility of shortline operations.

Senate May OK Convention

Senate has agreed to consider the Convention on International Civil Aviation written at Chicago in 1944, for ratification as a treaty. Sen. Owen Brewster (Maine) asked that action be postponed till next year because ratification would seem to indicate Senate approval of the President's "freedom of the air" policy, and because the temporary PICAO is scheduled to continue meeting till Dec. 1947. Mr. Truman, asking for Senate action, said the Chicago convention does not cover controversial commercial rights, these are to be settled through bilateral international agreements negotiated by the Executive. He will continue such agreements, such as the one consummated at Bermuda.

Several weeks ago the Senate Commerce Committee by a vote of 17 to 1, declared the Bermuda and Anglo-American commercial air rights agreement illegal, arguing such action could be taken only by CAB or by treaty. Now Attorney General Tom Clark has ruled that the agreement is legal, in conformity with the Act of 1938, and in conformity with the Constitution, which, he says, does not require that such agreements take treaty form. It is contended by authorities in Washington that only the Senate Foreign Relations Committee, not the Commerce Committee, would have the right to take a resolution on this matter. Meanwhile the Bermuda agreement remains in effect.

Overseas Routes Top 100,000 Mi.

U. S. overseas certificated airways now total 127,611 mi operated by eleven companies. The Latin American awards by CAB contributed 18,000 mi to this total. The decision gave Braniff 7,310 mi, Chicago & Southern 3,704, Eastern 1,968, Panam 1,612. Of 9,013,375 mi scheduled weekly by 163 companies in the world, U. S. domestic lines alone fly 4,918,841, and U. S. overseas lines fly 958,192. Figures on non-scheduled operations are not available. Russia is not included in the compilation. Five U. S. airlines exceed the miles flown of BOAC, largest foreign carrier.

House passed and Senate Appropriations Committee approved allocations of $49,000,000 for domestic and $5,000,000 for foreign airmail payments in the coming year. The items are included in Post Office budget for 1947. These allocations, probably under actual requirements, will be supplemented by the usual deficiency requests. Foreign payments can hardly be estimated, because rates have not been set by CAB and no one knows potential volume.

Route Fight Grows Bitter

An unusually bitter controversy developed around the Boston-New Orleans case hearing before CAB, seeking to establish an additional route competing with EAL and AA along the Atlantic Coast. There are about ten applicants, including several certificated carriers, one of which is PCA. Eastern and PCA, at hearings, charged each other with unethical attempts to influence communities along the coast, 35 of which had requested additional service. PCA wants to add links which would complete a trunk line to New Orleans. Among the contenders is Sam Solomon's Atlantic Airlines.

* CROSS COUNTRY *

TWA: Airline is transferring international maintenance and repair base from Newark Airport, N. J., to New Castle Airport, Wilmington, Del. . . . Company has taken delivery on an AAF Northrop P-61 to conduct thunderstorm detection research.

UAL: Company has adopted VHF radio as primary channel in plane-to-ground communications. In addition airline's Chicago freight pickup and delivery contractor, Willet Co., has installed Raytheon radiophones in trucks to speed up ground handling . . . Airline increased free baggage allowance for international travelers from 44 to 66 lb.

AA has taken delivery on DC-3 flying radar lab equipped by GE. Tests of radar's serviceability will be conducted.

Commander Line is new name for Willis Air Service, N. Y. Company operates six DC-3s and a DC-4.

New airlines: Bruning Aviation, Inc., 31 Elm St., Springfield, Mass., operating DC-3 freighters, is now offering service from Westfield, Mass., airport . . . Midwest & Southern Airlines is new Indianapolis intrastate service. . . . Flying Freight Inc., 42 Broadway, N. Y. C., is new cargo operator using twelve Vickers Stranraer flying boats and six land planes in service to Chicago, Miami and Caribbean area . . . Parachute Air Cargo Co., based at Oakland Municipal Airport, Cal., is lately organized concern that plans freight delivery by chute . . . Long Island Airlines is new Southampton, L. I., commuter line using Grumman Widgeon amphibians between downtown N. Y. C. ramp and Long Island points. Grumman Mallards are to be used later.

GREYHOUNDS ALOFT

In first test at Detroit, Greyhound Bus Co. demonstrates use of combined bus-helicopter service as prelude to test of operations using both types of vehicles to speed passenger transport in crowded areas. Shown landing adjacent to bus is three-passenger Sikorsky S-51, commercial version craft developed from R-5 military type. (Int'l News photo)

★ INTERNATIONAL BRIEFS ★

ENGLAND—**Fairey Gyrodyne,** combination helicopter and autogiro features single rotor, also regular engine with airscrew in nose. Engine offset to counteract torque, provides considerable traction, reportedly eliminating high rotor stresses at speed.

De Havilland announced $10,000,000 in orders for Dove, twin-engined feederliner, of which over $8,000,000 worth are for export. Gross weight of plane has been raised to 8,500 lb., giving payload of 1,900 lb. for maximum range.

New jet planes include the Brabazon III cruising at 370 mph., and a new model Vickers Viking with two jet engines.

Frank Whittle, who earlier resigned from Power Jets (Apr. 1946 Aviation), has been named technical adviser on engine design and production for Supply Ministry.

British European Airways now operates 89 schedules weekly from Northolt, with converted Douglas C-47's. Line serves all Europe, including Gibraltar, Athens, Lisbon, and Stockholm.

FRANCE—Air France inaugurated regular service to Buenos Aires and Santiago, Chile, few days before starting N. Y. operations. Both routes are presently operated with Douglas C-54s.

Private companies formed an association to promote operation of air services. So far, 34 permits have been granted by government for feederlines and air-taxi and charter operations. New group will present united front to handle legal and government matters for these operators.

CHINA—Rolls-Royce has completed license agreement with Chinese Government for manufacture of gas turbines and jet engines. Most personnel will be trained in England. Rolls-Royce will supervise construction of new plants.

SCOTLAND—Plans for separate Scottish airlines were dashed when British Government refused to sanction plans of Scottish Airways in nationalization bill. Matter is expected to be pressed for reconsideration, but ultimate success appears doubtful.

EIRE—Eire and Portugal demand right to require international airlines flying over country to land at their airports. Apparently conferences with trans-Atlantic operators (Feb. 1946 Aviation) did not result in desired guarantees of continued utilization of these countries' airports.

ITALY—Expected result of TWA-Italy agreement was formation of BOAC-Italian company, which will operate international airlines in competition with TWA.

RUSSIA—Use of bombers and reconnaissance planes to spot and destroy ice jams endangering bridges has been announced by Moscow. Different crews are flying in rotation, to broaden training values.

EGYPT—Announcement of U.S.-Egyptian air treaty followed transfer of Payne Field, U.S. base near Cairo, to the Egyptian Government. Availability of field for commercial operations was a condition of transfer. Treaty gives U.S. companies "fifth freedom" rights at Cairo, also right for technical stops at other points.

SUDAN—Local government has organized Sudan Airways, a combination of existing companies and railways. Fleet of aircraft will be started with four DH Doves.

SOUTH AFRICA—Government announced it will negotiate air treaties on basis of complete reciprocity only. Only agreement of this type is pact with Britain covering so-called Springbok service.

AUSTRALIA—Wide, uninhabited expanses in Australia are being studied for location of proposed rocket and missile development program by British Government.

Australian National Airways received permission to operate temporary service to North America on behalf of British Commonwealth Pacific Airlines. Contract, running for one year, provides for twice-weekly schedules with Douglas DC-4s.

ARGENTINA—Following completion of reciprocal agreement with Britain, FAMA, government airline, started preparations for test flights to Britain via France, using Short flying-boats leased from Dodero.

New airmail line, SAOE, started thrice-weekly operations on four routes, each involving about 10 hr. flying to out-of-way towns.

Alfredo F. B. Lopez has been elected a member of board of directors of Aeroposta, and he is expected to return to this country for extensive purchasing program after getting acquainted with proposed operations.

CHILE—National airline, LAN, signed reciprocal agreement with FAMA providing landing rights in Argentina and temporary permission to operate to Buenos Aires. Company received additional Douglas C-47s for its proposed expansion in this area.

Airports at Santiago and Antofagasta are to be expanded to include 8,000-ft. runways, also complete lighting and beacon systems. Government and private sources supplied finances which amount to the sum of $800,000.

BOLIVIA—Bolivian Development Commission acquired several Curtiss C-46 Commandos from U.S. surplus for as yet undisclosed plans.

MEXICO—Permit of Aerovias Braniff to operate to Havana was cancelled when service was not started within period provided. Company appealed to Mexican Supreme Court, but considerable time is expected to elapse before case is brought up for hearing.

WORLDATA . . . . By "VISTA"

Numerous small non-scheduled airlines are appearing in Britain. Technically listed as charter companies, some of them are offering fairly regular services. Among the latter is Skyways, Ltd., just formed in London, and it's notable that its organizer and board chairman is Gen. Critchley who resigned some time ago as director-general of British Overseas Airways Corp. Company is acquiring Avro Yorks and Lancasters for long-distance services, and Percival Proctors and similar types for shorter flights. Contracts include regular flights of tourists to Switzerland, of oil company employees to Iran.

Just how Skyways' operations are going to be accepted by England's labor government under its nationalization plans is not known. Gen. Critchley left BOAC over nationalization plans, and many quarters feel that Skyways is his answer, and a challenge. Britain's airline nationalization bill would make any charter company operating between points served by any government airline subject to scrutiny and possible criminal action. Skyways undoubtedly will offer formidable competition, since preliminary rates indicate that, for large groups, savings over recently reduced airline fares can be effected.

Twelve other charter companies operate about 50 aircraft, ranging from Austers to DH Rapides. Rates generally run from about 20¢/per mi. for Austers to 50¢ for Rapides.

While the nationalization bill has not yet become law, negotiations have already been started on amounts to be paid smaller operators in England. First settlement announced involved Railway Air Services getting about $2,000,000, after nearly $3,000,000 had been asked. However, other operators threaten lengthy arguments which may hold up passage of the bill many months. Except for Railway Air Services all others suspended operations at the start of the war, handing over their operations to the government. These companies, which are quite numerous, claim that they were assured of resumption after the war. Meanwhile, the government states that these lines do not qualify for compensation, since they ceased operations. Because suspensions were at the request, or even direction of the government, even if different from the present powers-that-be, it looks likely that there will be considerable opposition until this question has been settled. It should be remembered that much pressure arose against the nationalization bill because of the cost to the taxpayer, and the present Government attitude may well be an attempt to cut down on the cost.

GOING DOWN SOUTH AMERICA WAY

Interior of rear cabin of Avro York going in service for British South American Airways. This cabin seats 15 passengers, while forward compartment seats 6. Cargo hold of 200 cu. ft. capacity is located aft of galley, luggage compartments are ahead of forward cabin.

NEW SWISS EAGLE

Interesting application of swept-forward wing design is seen in this Swiss 4-6 place single engine plane, specially designed for mountain flying. Powered with a 440 hp. Pratt and Whitney Wasp Jr. engine, Pelican, as it has been named, was designed during war by Swiss Aero-technical Association and Swiss Institute of Technology, and constructed by Pilatus Aircraft Co., Stans, Switzerland. Fuselage is metal skin-stressed construction, with sound-proofed cabin. Wing is wood construction with plywood skin. Pelican has top speed of 143 mph., cruising speed of 125 mph. and will fly safely at a minimum speed of 47 mph. when flaps are used. (Aeroplane Photo)

* CANADIAN NOTES *

By James Montagnes

Fairchild Aircraft Ltd., Montreal, has started production on new Canadian designed freighter F-11 Husky, 7 to 8 passenger all-metal transport or cargo plane designed following survey of bush pilot requirements. Planes are expected to be in production late this autumn and are to be available with wheel, ski, or pontoon landing gear, and powered with new or used Pratt & Whitney Wasp SB3 or TB3 engines.

Engineering Products of Canada Ltd., Montreal, is building first Canadian helicopter, the Sznycer & Gottlieb Mark VI. Prototype was scheduled to be ready during the summer. It is designed to carry two passengers and pilot plus approximately 100 lb. of baggage.

Canadair Ltd., Montreal, government-owned company, is making Canadian version of Douglas DC-4 for Trans-Canada Air Lines and for export. Aircraft will be powered with Rolls-Royce Merlin engines.

NEA and PAA have been licensed by Canadian Air Transport Board to operate routes into and out of Canada. Northeast operates Boston-Montreal and Boston-Moncton service, while Panam has Whitehorse, Yukon, to Fairbanks, Alaska, run. . . . New Canadian operators licensed in recent weeks to operate charter services include Muskoka Air Trails in North Ontario and M & C Aviation at Prince Albert and Big River, Sask.

Canadian Air Transport Board issued a large number of charter non-scheduled air service licenses to new companies during early Summer. It also issued licenses for first time to American airliner operating into Canada. WAL has been licensed to operate between Lethbridge, Alta., and Great Falls, Mont. . . NWA between Winnipeg and Fargo, N. D., UAL between Vancouver and Seattle. TCA has been licensed to operate Toronto-Chicago, Toronto-Cleveland, Seattle-Vancouver, Ft. William-Duluth services, first two of which have been started.

Cub Aircraft, Hamilton, Ont., is now turning out one plane daily, expects soon to produce Super Cruiser and Skysedan. Plans for new facilities to make Cruiser are nearing completion with announcement of a financing plan for $400,000 expansion of Cub Aircraft's plant. Super Cruiser is to sell in Canada for about $3,600 and is to be available for wheel, ski, or float landing gear. While awaiting production, Cub Aircraft has ordered 200 aircraft from Piper.

Bell helicopter is being used in mining exploration in northern Canada this Summer, marking first employment of 'copter in mineral prospecting. Craft carries magnetic mining detection instruments.

Industry shorts: A. V. Roe Canada, Toronto, started tooling up to produce Tudor II, also is converting five Lancaster bombers to RCAF troop transports. Company likewise is understood to be planning RCAF jet-propelled fighter. . . . Cub Aircraft, Hamilton, Ont., has appointed 20 dealers. . . . Fleet Aircraft, Fort Erie, Ont., reports 1945 net profit of $160,596 as against $185,768 in previous calendar year.

TCA: Airline opened offices in Chicago and Cleveland for Toronto-Chicago and Toronto-Cleveland daily services starting this month. . . . High-speed teletype radio circuits have been opened between Montreal and Moncton, and between Moncton and Prestwick. . . . Next year, Montreal-Quebec-Riviere du Loup-Mont Joli-Campbellton-St. John, N.B. route is to be inaugurated, when airfields at Riviere du Loup and Campbellton have been completed.

TCA is testing SCS-51 instrument approach flying system at Stevenson Field, Winnipeg, Man., with runway localizer transmitter in a truck to guide pilots onto runway to be used in bad weather. These tests are to check localizer beam for accuracy of heading, width, and terrain effects such as bending.

AVIATION FINANCE

ADDING IT UP.....By RAYMOND HOADLEY

Beech Deal With Dutch. Preliminary negotiations have been held looking toward acquisition by Beech of a financial interest in Holland's Fokker Aircraft works but definite decisions on this or other foreign arrangements awaits the return of Pres. Walter Beech from a European trip during which he was studying the situation. Meanwhile Beech has arranged a $4,000,000 bank loan to finance materials and other production requirements.

Stock-Splits. United Aircraft Products proposes to split its common stock on a two-for-one basis while American Overseas Airlines will split its capital stock three-for-one. American Airlines owns 51% of American Overseas stock. Taylorcraft has split its stock three shares for one.

New Financing. Continental Motors is selling $12,000,000 of convertible preferred stock to expand its Muskegon, Mich., plant capacity by 66% and for possible additional plant facilities and for working capital needs . . . Chicago & Southern Air Lines is issuing 170,000 shares of new stock. The proceeds, amounting to $4,000,000, will be used to buy equipment and build a new hangar and office building . . . U. S. Airlines is selling 900,000 shares of common stock. Proceeds will be used to pay a $250,000 bank debt and for expansion.

Bank Credits. Fairchild Engine & Airplane Co. has reduced its bank credit from $10,000,000 to $5,000,000 . . . Lockheed has arranged a $30,000,000 revolving bank credit and may borrow $10,000,000 more to buy Defense Plant Corp. facilities. . . . Consolidated Vultee has a new three-year credit agreement whereby it may borrow up to $25,000,000 from a group of banks.

Unfilled Orders. Latest unfilled orders to be reported include: Lockheed, $205,000,000; Fairchild, $68,000,000; Continental Motors, $110,000,000; Consolidated Vultee, $264,000,000; and Kellett Aircraft, $5,400,000.

Lockheed Reports. Sales of Lockheed last year were $415,000,000 against $602,000,000 in 1944, while net income jumped to $5,469,000 or $5.08 a share against $4,522,000 or $4.20 a share the previous year. Pres. Robert Gross recently told the press that a merger with Curtiss-Wright Corp., as has been frequently rumored, is not contemplated. But he did not rule out the possibility of "other mergers in the aircraft manufacturing field."

Other Reports. Consolidated Vultee reports 1945 net income of $7,028,000 or $4.92 a share against net of $12,424,000 or $8.80 a share in 1944. Sales were $845,000,000 against $860,000,000 the previous year . . . Solar Aircraft reports net income of $470,000 or 88c. a share for the year ended Apr. 30, against net of $640,000 or $1.65 a share the previous year. Sales were $22,755,000 against $29,031,000 a year earlier.

Personal Plane Companies. Luscombe Airplane Corp. realized a net profit of $34,717 on sales of $6,509,000 last year compared with $161,386 and $4,017,000, respectively, in 1944. Nearly 1,000 employees have adopted a profit sharing plan, according to Pres. L. H. P. Klotz, whereby they will receive one-third of net profits before tax deductions. . . . Aeronca is producing 43 planes daily and expects to build 10,000 in 1946, according to Pres. J. W. Friedlander. . . . Piper Aircraft recently had unfilled orders of $15,000,000.



LEON A. "JAKE" SWIRBUL (left) has been elected pres. of Grumman Aircraft succeeding **LEROY A. GRUMMAN** (center), who was appointed to newly created post of chairman of board in which capacity he will continue to devote his full time to affairs of company. **WILLIAM T. SCHWENDLER** (right) was elected exec. vice-pres. succeeding Mr. Swirbul and will retain his post as chief engineer. These men were founders of corporation in '30 and have been its most active officials since. Both Mr. Swirbul and Mr. Grumman recently were recipients of Medal for Merit, highest civilian award for war service in recognition of their record breaking production of Wildcats, Hellcats, Tigercats, and Avengers for Navy.


CHARLES D. MANHART (left) has been made sales mgr. in charge of all aircraft product sales for Bendix. He joined company in 1935 and was identified with technical development of Stromberg injection carburetion and allied fuel systems. A Purdue graduate, he served later with AAF's 1st Pursuit Group. **J. F. RICHARDSON** (right) is company's new asst. sales mgr. During war he was responsible for entire scheduling on plane landing gears for AAF.

NOEL B. McLEAN has been appointed exec. vice-pres. of Edo Aircraft. Previously with Bendix Aviation, he has been in aircraft accessory manufacturing business for past 17 yr. He is member of Society of Naval Architects, also Army Ordnance Assn.

R. D. MACDONALD has been named staff asst. to gen. sales mgr. of Convair's Stinson Div. During war, he served as Washington director of Aircraft Div. of Canada's Dept. of Munitions & Supply, and he was organizer of Aircraft & Radio Div., Dominion's WAC.

FRED W. ZELLMER joined Southwest Airmotive at Love Field, Dallas, as coordinator of maintenance activities for private flyers. While in AAF he supervised development of B-24, C-87, C-74, and C-69. With Convair he worked on B-32. (Collins photo)

BURHAM ADAMS has been appointed West Coast sales mgr. of Electro-Mechanical Div. of Lear, Inc. Previously, he was West Coast mgr. of Wright Aero where he had been for 23 yr. He is a member of SAE and associate fellow of IAS. His hq. will be in Los Angeles.

W. H. "BOB" NEFF has been named special asst. to pres. of UAL with hq. in N.Y.C. Previously, he was pub. rel. mgr. of Atlantic Div. of PAA. During war he served as comdr. in Navy with position of aviation asst. to director of public relations.

JOHN F. WOODHEAD has been appointed operations mgr. for NWA. With airline since '32, he was formerly system chief pilot and gen. mgr. of NWA's Northern Region. During war, he flew military cargo planes in Alaska and Aleutian Islands.

REAR ADM. CHARLES E. ROSENDAHL has been relieved as chief at Lakehurst, N. J., NAS pending retirement from Navy. He has been a naval aviator in lighter-than-air ships for past 23 yr., being renowned as a foremost expert in art of aerostation.

H. F. BROWN has been named vice-pres. in charge of production-manufacturing for Boeing with hq. in Seattle. He has been associated with company for 15 yr. and was formerly works mgr. in Wichita Div., where he started as chief draftsman.

P. HOWARD FARLEY has been appointed supt. of training for Braniff. His duties will consist of administration of airline's extensive training dept. for new employees. He served 4 yr. in AAF during war, became a pilot, and attended general staff school in Kansas.

B. R. "BOB" TEREE has joined Weatherhead Co. as project engineer in charge of aircraft development. Earlier, he was with Curtiss-Wright Corp., Airplane Div. He is chairman of SAE Committee A-6, also member of ASME and SAE engineering societies.

NEW PRODUCTS

KEEP POSTED ON
Products and Practices

This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save valuable time, provides profits through convenience. To obtain literature or additional data on new products described, simply fill in form below, clip it to your letterhead, and mail. There is no cost, no obligation.

INFORMATION TIPS

ENGINEERING DATA

Cleaning Methods and Materials . . . 1

Including information on still cleaning, electro-cleaning, preparation for painting, and anti-rust treatment new bulletin from **Kelite Products**, Los Angeles, also describes pH controlled cleaning methods and materials.—**AVIATION, Aug., '46**

Aluminum Alloys . . . 2

Containing information on aging characteristics, mechanical and physical properties as sand cast and chill cast, and chemical composition bulletin issued by **National Smelting Co.**, Cleveland, describes series of aluminum-magnesium-zinc alloys stated to possess high elastic properties.—**AVIATION, Aug., '46**

Heat Treating . . . 3

Covering factors concerning hardness and toughness and containing charts, diagrams and photographs, bulletin "Suiting the Heat Treatment to the Job" published by **United States Steel Corp.**, Pittsburgh discusses fundamentals of heat treatment.—**AVIATION, Aug., '46**

Pyrometers . . . 4

Booklet No. 191 t issued by **Brown Instrument Co.**, Philadelphia, presents information on how to order thermocouples, protecting tubes, and thermocouple wire also includes descriptions of standard thermocouple units.—**AVIATION, Aug., '46**

Forgings . . . 5

Published by **Steel Improvement & Forge Co.**, Cleveland, booklet "The Improvement of Metals by Forging," describes equipment, tools, materials and forging techniques used in closed impression dies.—**AVIATION, Aug., '46.**

Aluminum Castings . . . 6

Including technical data on how sound metal quality is obtained in permanent mold aluminum castings bulletin issued by **Permold Co.**, Medina, Ohio points out economical methods in designing parts for this type of castings.—**AVIATION, Aug., '46**

Diamond Dies . . . 7

Explaining how diamond dies are made, Booklet No. 6-1049 from **North American Philips Co.**, New York City describes various applications of dies in industry.—**AVIATION, Aug., '46.**

Precision Castings . . . 8

Kerr Dental Mfg. Co., Detroit, has issued booklet, "Fundamentals of Industrial Precision Casting" to outline principles involved in producing accurate and dense castings.—**AVIATION, Aug., '46.**

Welding . . . 9

Diagrams, facts and tables relating to welding with Ampco-Trode and Phos-Trode electrodes are contained in consumers issue of Ampco Welding News (No. WNC-1) published by **Ampco Metal**, Milwaukee.—**AVIATION, Aug., '46**

PRODUCTION

Welding Rods . . . 10

Special war production review issue of "Eutectic Welder" published by **Eutectic Welding Alloys Corp.**, New York City shows applications of company's welding rods in aviation industry.—**AVIATION, Aug., '46**

Tachometer Test Stand . . . 11

Literature from **Ideal Laboratory Tool & Supply Co.**, Cheyenne, Wyo. describes Model 1810 tachometer test stand having speed drives adjustable from 100 to 3,400 rpm giving an indication on aircraft tachometers of 300 to 6,800 rpm.—**AVIATION, Aug., '46.**

Metal Cleaner . . . 12

Service report from **Oakite Products**, New York City describes Composition No. 98 stated to remove light shop dirt and non-pigmented stamping compounds from steel and aluminum.—**AVIATION, Aug., '46**

Diamond Compound . . . 13

Developed for production lapping of gages and production parts requiring uniform high finish new diamond compound is described in folder from **Engis Equipment Co.**, Chicago.—**AVIATION, Aug., '46**

Centering Tool . . . 14

Designed to locate templates in relation to workpiece and to center drill jigs to reference marks, new instrument, Opti-Setter, is described in literature from **Benton Co.**, Los Angeles.—**AVIATION, Aug., '46**

Fibrous and Plastic Materials . . . 15

Rogers Corp., Manchester, Conn., offers free production samples of fibrous and plastic sheets from as little as 25 lb of component ingredients made possible by experimental machine which is said to duplicate full scale equipment.—**AVIATION, Aug., '46**

Induction Soldering . . . 16

Developed for production soldering of small parts and assemblies new portable bench-type induction soldering unit is described in bulletin from **Marion Electrical Instrument Co.**, Manchester, N. H.—**AVIATION, Aug., '46**

Wire Connections . . . 17

Description and engineering data are

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Please send me additional information on item indicated (write number in circle) ➡ ◯ Company Name Address Your Name Your Title AVIATION, 330 West 42nd St., New York 8/46	Please send me additional information on item indicated (write number in circle) ➡ ◯ Company Name Address Your Name Your Title AVIATION, 330 West 42nd St., New York 8/46

available from Aircraft-Marine Products Co., Harrisburg, Pa., regarding solderless connections for solid or stranded wire or combinations of both.—AVIATION, Aug., '46.

Welding Electrodes 18

Bulletin from Metal & Thermit Corp., New York City, describes line of welding electrodes developed to weld steels which are difficult to weld, such as high sulphur free machining steels, high carbon steels, cold rolled steels and cast iron.—AVIATION, Aug., '46.

Label Dispenser 19

Developed for use with Quik-Label cards, new dispenser is announced by W. H. Brady Co., Milwaukee.—AVIATION, Aug., '46.

Bucket Pump 20

Holding 30 lb. of lubricant and featuring automatic venting device in pump tube, new bucket pump is announced by Lincoln Engineering Co., St. Louis.—AVIATION, Aug., '46.

Three Dimensional Machine Templates.21

Developed to provide plant layout engineers with a tool for visualizing overall projects and made to ¼ in. scale, three dimensional machine templates are described in catalog issued by Visual Production Planning, Inc., New York City.—AVIATION, Aug., '46.

MACHINERY & ACCESSORIES

Parts Washer 22

Employing impeller to force fluid solvent into washing chamber, new parts washer is described in folder issued by Bagnell Washing Equipment, Inc., Chicago.—AVIATION, Aug., '46.

Relief Valve 23

Designed to maintain a pre-determined pressure by relieving any excessive pressures that may occur in fuel and hydraulic lines, new relief valve is announced by Aerotex Co., White Plains, N. Y.—AVIATION, Aug., '46.

Tool Holder 24

Catalog No. 464 issued by Bokum Tool Co., Detroit, describes tool holder with vertical adjustment for holding boring tools in lathes.—AVIATION, Aug., '46.

Circuit Control Pump 25

Bulletin describing operating principles, features, engineering data and applications of hydraulic circuit control pump has been published by Sundstrand Machine Tool Co., Rockford, Ill.—AVIATION, Aug., '46.

Hydraulic Press 26

Watson-Stillman Co., Roselle, N. J., has issued Bulletin No. 300-A describing 40 ton hydraulic press designed for short production runs, testing, or for hot or cold plastic molding.—AVIATION, Aug., '46.

Hand Grinder 27

Description and specifications of 4 in. manual pneumatic grinder are given in catalog page from Master Pneumatic Tool Co., Cleveland.—AVIATION, Aug., '46.

Power Shears 28

Incorporating pivoted blade principle, Steelweld shears are described in Catalog No. 2011A offered by Cleveland Crane & Engineering Co., Wickliffe, Ohio. Machines have capacities up to 1½-in. for mild steel.—AVIATION, Aug., '46.

Drilling Machine 29

Designed for drilling up to 1¼-in. in cast iron or its equivalent in other metals, new 21-in. drilling machine is described in Catalog No. 61 issued by Sibley Machine & Foundry Corp., South Bend, Ind.—AVIATION, Aug., '46.

Gear Chucks 30

Information is available from Garrison Machine Works, Dayton, Ohio, on spur gear chuck for boring mill in airplane engine plant, bevel gear chucks for grinding operations on Zerol type gears and on duplex gear chucks for grinding bore of close coupled airplane propeller gears, and for chucking cluster gears by pitch line of two-end gears.—AVIATION, Aug., '46.

Milling Machine 31

Having a table 42 x 12 in. with an automatic cycle and a 20 in. travel, new milling machine, Model 4-A Vertical, is announced by Kent-Owens Machine Co., Toledo, Ohio.—AVIATION, Aug., '46.

Dieless Duplicating 32

Catalog No. 48-10 issued by O'Neil-Irwin Mfg. Co., Minneapolis, describes line of machines for dieless duplicating of formed and bent parts.—AVIATION, Aug., '46.

Lathe Gear Box Attachment 33

Designed to increase production and shorten time for gear changing, new gear box attachment for lathes is announced by Western Aircraft Tool Co., Los Angeles.—AVIATION, Aug., '46.

Turret Tapper 34

Incorporating a reversing tapping head in one position, new turret tapping head is made by Universal Engineering Co., San Diego, Cal., to drill and tap in one operation at same station.—AVIATION, Aug., '46.

Releasing Tap Holder 35

Developed to compensate for parallel and angular misalignment and eliminate binding which causes tap breakage, new Tool-Flex releasing tap holder is announced by Burg Tool Mfg. Co., Los Angeles.—AVIATION, Aug., '46.

ELECTRICAL

Condensers 36

Made in two and three gang units, new variable condensers are described in literature from Airadio, Inc., Stamford, Conn.—AVIATION, Aug., '46.

Contact Connectors 37

Molded of plastic and designed to eliminate prying and pulling to disengage, new self-separating contact connectors are described in Bulletin No. 321-K issued by Winchester Co., New York City.—AVIATION, Aug., '46.

Relays 38

Containing section listing special types of solenoid contactors used by aviation industry, new 4-page catalog published by Leach Relay Co., Los Angeles, describes light and heavy duty circuit control, sensitive, telephone, make-before-break, time delay, high frequency, and keying types of relays.—AVIATION, Aug., '46.

Resistor Tester 39

Developed to test large quantities of resistors, new low range limits bridge, Model 87-A, is announced in Bulletin No. 308 issued by Associated Research, Inc., Chicago.—AVIATION, Aug., '46.

Relay Equipment 40

Made for large load capacity by Sigma Instruments, Boston, Series 41 relays can be used on a.c. or d.c. and are made in both plug-in and unenclosed types.—AVIATION, Aug., '46.

Finishing Motor Rotors 41

National Broach & Machine Co., Detroit, announces new method of finishing electric motor rotors by means of fine pitch cutters. Tendency to close laminations is reported eliminated.—AVIATION, Aug., '46.

Vacuum Tube Voltmeter 42

Designed for use on production testing, Model 668 is a.c. and d.c. vacuum tube volt, ohm, and capacitymeter made by Radio City Products Co., New York City.—AVIATION, Aug., '46.

STEELS

Dense Alloys 43

Information is available from Callite Tungsten Corp., Union City, N. J., on series of dense alloys stated to have density of .608 pounds per cubic inch and known as Dense Alloy 112.—AVIATION, Aug., '46.

Steel Tubing 44

Folder from Summerill Tubing Co., Bridgeport, Pa., gives description of line of cold drawn seamless tubing made for special purposes and with inside dia. down to .004 in.—AVIATION, Aug., '46.

PLASTICS AND SYNTHETICS

Abrasives Used With Plastics 45

Containing information on use and application of coated abrasives in plastic industry, new booklet published by Behr-Manning, Troy, N. Y., also has chart describing plastics under their trade names.—AVIATION, Aug., '46.

Laminated Plastics 46

Catalog DD-5 issued by Continental-Diamond Fibre Co., Newark, Del., describing line of laminated phenolic plastics contains comparative chart showing electrical and mechanical properties of Dilecto sheet grades.—AVIATION, Aug., '46.

Plastics Information 47

Having uses in aircraft industry, plastics made by Dow Chemical Co., Midland, Mich., are discussed in "Plastics Primer," which describes their properties, fabrication, and uses.—AVIATION, Aug., '46.

Plastics Quiz 48

Limited to seven questions, "Plastics Specification Quiz" issued by Creative Plastics Corp., Brooklyn, N. Y., is designed to guide manufacturers to use right plastic in right place.—AVIATION, Aug., '46.

Protective Coating 49

Folder from Merchants Chemical Co., Stamford, Conn., describes Cordo-Clad 1000, a plastic base protective coating applicable to wood, metal or concrete, telling what it is, what it will do and how to use it.—AVIATION, Aug., '46.

AIRCRAFT & ACCESSORIES

Hydraulic Test Machine 50

Designed for use in line testing performance and operation of aircraft hydraulic systems operating up to 3,000 psi., new Model PGS-8 gasoline powered testing machine is covered in specifications issued by Greer Hydraulics, Brooklyn, N. Y.—AVIATION, Aug., '46.

Aircraft Compass 51

Designed to AAF specifications, direct reading plastic pocket compass, described in booklet issued by Du Page Plastics Co., Chicago, is now available to civilian flyers.—AVIATION, Aug., '46.

Propeller Angle Measurement Device.52

Actuated by gravity and requiring no reference to surfaces other than propeller blade, new instrument, Pitchometer, is made by Thos. J. Whitehester Enterprises, San Diego, Cal., to measure pitch angle of aircraft propeller blades. (This instrument was described and illustrated on page 58 of June AVIATION.)—AVIATION, Aug., '46.

Aircraft Tires 53

Containing tables on tire equipment specifications for current light aircraft, new catalog from B. F. Goodrich Co., Akron, also describes de-icers, propeller abrasion protectors, and other aircraft accessories.—AVIATION, Aug., '46.

Airplane Engine Manual 54

Literature and operations manual published by Lycoming Div., Aviation Corp., Williamsport, Penna., describes Model

9-28-C aircraft engine giving specifications and information on operation service inspection and maintenance.—AVIATION, Aug., '46

AIRPORTS

Fuel Dispenser 55

Developed to meet needs of small plane fueling, Model 2212, 20 gpm above ground cabinet-type fuel dispenser, is described in folder published by **Erie Meter Systems**, Erie, Pa.—AVIATION, Aug., '46

Air Conditioner 56

Developed to meet temperature conditions ranging from minus 30 to plus 120 deg., new mobile unit for air conditioning airliners while they are at airports, is described in bulletin from **Clarke Climate Control Co.**, Milwaukee.—AVIATION, Aug., '46

MERCHANDISING

Display Miniatures 57

Created by sealing a photograph to plywood and cutting out to contour photographic models called Photoette Miniatures are stated to give three dimensional effect. They are described in a folder issued by **Photoettes By Isom**, Kansas City, Mo. It is suggested that these miniatures may have display and promotional uses in aviation field.

NEW PRODUCTS

Aircraft Parts & Field Units

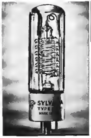
Regulated Output Amplifier 58

Designed for use in airways and other voice communication circuits to provide automatic noise suppression and rms. level control, Series 8138 regulated output amplifier made by **Schuttig & Co.**, Washington, D. C., is a high gain push pull amplifier. Through two additional features, it is stated able to hold rms. output level within 1 db. with input variations as great as 40 db., also to automatically reduce gain by factors up to 22 db. during periods of circuit idleness. Frequency response is stated to be uniform to within 1 db. over range

of 100 to 4,000 cycles, and for a condition of 40 db. compression distortion not to exceed 3%. Sustained transients caused by abrupt input level changes are said to be eliminated; full automatic control being established within approximately two voice cycles at any frequency. Maker states hum and noise level are over 45 db. down from zero level. Equipment is available for use as a 75 db. microphone amplifier or as a 50 db. line amplifier. Unit consists of vertical panel and chassis combination with all components, controls and adjustments mounted on rear of chassis.—AVIATION, Aug., '46

Electronic Flash Tube 59

Designed to provide instantaneous high intensity light for airway beacons, airport boundary markers, and other signaling equipment, new gas discharge flash tube has been announced by **Electronics Div., Sylvania Electric Products**, New York City. Tube may be operated in condenser discharge circuit to provide flashes of 1/5,000 sec. duration with peak output of 12 mil-



lion lumens. Daylight type light with color temperature ranging between 6,000 and 7,000 K. is produced in a xenon discharge cell. Equipment may be designed to operate from portable battery power or directly from 120V a-c line. Several of these tubes can be arranged on an airport and discharged in sequence to light and show direction of runways. High light output is stated to cut fog and similar atmospheric conditions. Tube No. R4330, mounted in a T-21 bulb, measures 4 15/32 in. over medium ceramic octal base. It is of 2 15/32 in. dia. and has rated life of over 10,000 flashes.—AVIATION, Aug., '46.

Cleaning Materials 60

Developed to clean fabric surfaces, Flaxoap, made by **Sherwin-Williams Co.**, Cleveland, is a linseed oil soap which is stated not to discolor or harm any fabric-finished airplane or to affect paint film of fabric. Although mild it is made to dissolve dirt which has lodged on covering. Another company product is a metal polish made to remove grease and dirt from metal surfaces. This is to be used only on unpainted portions of metal planes.—AVIATION, Aug., '46

Cartographic Camera 61

To provide rigid precision aerial photographs for topographical and planimetric maps, **Fairchild Camera & Instrument Corp.**, Jamaica, N. Y., has designed new 9 x 9 in. cartographic camera. Its focal length, field of view, negative size, construction tolerances, and other specifications have been planned to permit employment of its negatives in multiplex projector and other stereoscopic plotting instruments. Camera, which may be operated automatically and semi-automatically, has two cones, one inside other. Inner cone containing focal plane and optical system, can be removed as a complete unit for

calibration. Outer cone contains operating mechanism accessible for servicing. Front and rear lens elements may be removed for cleaning and inspection without disturbing collimation. A choice of three focal lengths are offered: 5½ in. f/2 aerogon, 6 in. f/6.8 aerogon and 8 in. f/6.8 aerostar. Shutter speeds are 1/50, 1/100, 1/200 and 1/300 sec. Magazine holds 180 ft of roll film, with capacity for 250 exposures of 9 x 9 in. negative size. Photo shows inner cone.—AVIATION, Aug., '46.

Motor Scooter 62

Fitted with standard checkered flag and useful as airport guide car, new motor scooter is built by Salsbury Motors, Inc., Los Angeles. It is equipped with automatic clutch and automatic transmission, hence

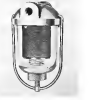
only controls required are accelerator and brake. Machine is stated to deliver about 65 mi. to a gallon and to have a top speed of 45 mph.—AVIATION, Aug., '46.

Radio Receiver 63

By inserting proper crystal and tuning RF adjustments any frequency in 108 to 132 mc. band may be set up with new single-channel crystal-controlled VHF receiver, Model 150-A made by **Federal Telephone & Radio Corp.**, Newark, N. J. Designed to meet needs of airline communications and airport traffic control, it has just been introduced to commercial aviation. It is stated to be useful for remote station contact with planes in course of flight and to airports for traffic control work from tower. Receiver mounts in standard 19 in. relay rack and is 7 in. high and 9 in. deep. Resistor boards, fixed capacitors and all wiring are on inner surface of chassis, and voltage checking and maintenance can be done without removing unit from its rack.—AVIATION, Aug., '46.

Gasoline Purifier 64

Used in aircraft, land vehicles and naval units during war, gasoline purifier unit made by **Skinner Purifiers**, Detroit, continues in use in commercial field. Unit purifies gasoline or other fuel by passing it be-



tween layers of helically wound ribbons made from impervious material. Dirt and other impurities are stopped at outer edges of these ribbons and fall into sediment chamber. Accumulations on outer surface of cylinder of ribbons occurring after long use can be cleaned off by blowing air into cylinder. Purifier is stated to separate free water from gasoline.—AVIATION, Aug., '46.

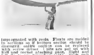
Aircraft Communication Units....... 65

Collins Radio Co., Cedar Rapids, Iowa, announces two new aircraft communication units, 18S transmitter-receiver and 180K antenna loading unit. Transmitter-receiver unit covers frequency range of 2.0 to 18.0 mc. Altitude range is 25,000 ft. for full power operation at more than 100w. out-

put. Equipment is designed to operate into 50 ohm transmission line, and remote control is provided. Receiver features avc, automatic noise limiter, optional dual output, one stage of RF amplification and an output of 100w. It operates from a 26.5v source. Antenna loading unit has nominal input impedance of 50 ohms and will handle input power up to 125w. It is designed to couple into standard aircraft antennas of 50 ft. length over a frequency range of 2.0 to 18.0 mc. up to 25,000 ft. altitude, and over a temperature range of minus 40 to plus 50 deg. C. Unit is provided with ten pretimed channels.—AVIATION, Aug., '46.

Airplane Floats 66

Made of plastic reinforced with Fiberglas, stated to have great tensile strength, new molded plane floats are being made by **Heath Co.**, Benton Harbor, Mich. Basic material is a felt-like mat of glass fibers



impregnated with resin. Floats are molded in sections so if bottom section should be damaged, entire section can be replaced with screw driver. Units are put on with bill and nickel attaching gear. Right and left floats are interchangeable. Each unit has 10 in. wide walk covered with non-skid material. They are designed to come up on step automatically when throttle is opened and are stated to fly themselves off water with trim tab full tail heavy.—AVIATION, Aug., '46.

Cleaner 67

Designed for employment in steam cleaning use at air bases is seen for new cleaner made by **Penstone Co.**, Tenafly-

N. J., which is a liquid compound and water soluble. Compound is alkaline and is reported to remove grease, oil and grime accumulations from surfaces on which steam cleaning may be used while not affecting paint or other finishes. Solution need not be preheated. Water and cleaner, in correct proportions, are poured into equipment tank.—AVIATION, Aug., '46.

Time-Charge Calculator 68

Designed to be easily read and to eliminate pencil and paper errors which occur when calculating aircraft rental charges,

new plastic flight-time-charge calculator is made by **Glencraft Co.**, Los Angeles. Unit is 6½ in. in dia. and is made of heavy gauge white plastic material.—AVIATION, Aug., '46.

Portable Oil Filter................69

Designed by **Hilliard Corp.**, Elmira, N. Y., this portable oil filter does not require operation of aircraft power plants, states maker. Oil maintenance service may be carried on without removal of aircraft from flight operations, and filter battery is capable of processing a minimum of 1,200 gal. of lube

oil before a change of filter elements is necessary. It's stated unit will service four-engine planes in not over 30 min. Storage capacity is 200 gal. and rate of filtering and delivery is 15 gal. per minute. Unit is 90 in. long, 62 in. high, and 50 in. wide. Dry weight is 1,500 lb.—AVIATION, Aug., '46.

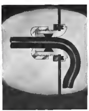
Tunable VHF Receiver..............70

Available for use on omni-directional range, new tunable VHF receiver is announced by **Aircraft Radio Corp.**, Boonton, N. J. Covering range of 108-132 mc. and including associated converter and indicat-

ing units, receiver is stated to contain all circuitry necessary for flight operations and experimental phase-comparison localizer installations. While constructed to meet high electrical and mechanical standards this unit does not necessarily represent final design as to packaging and physical layout.—AVIATION, Aug., '46.

For Cabin Fabrics 71

Designated as Sentry Flamegard and made by Sentry Products Co., Inglewood, Cal., new product is stated to have exceptional flame and moth proofing qualities in connection with airplane cabin textiles. Two other varieties for special applications are stated to protect wood and canvas from fire and destructive pests for long periods.—AVIATION, Aug., '46.



Shop Equipment & Materials

Vise Jaw Caps 72

Copper, brass, or plastic vise jaw caps known as Softjaws are made in seven sizes (from 3 to 8 in.) by Gregory Tool & Mfg. Co., Detroit. Metal caps are made from mill bars to give soft surfaces without hard spots to grip all classes of finished work. Plastic caps are recommended for finished soft metal surfaces.—AVIATION, Aug. '46.

Cable Clamp 73

Designed to permit secure and distortionless anchor for various sizes of jacketed cables and to act as a barrier to flow of moisture along outside of cable cover, new type of cable clamp is now available from H. H. Buggie & Co., Toledo, Ohio. Tightening of nut at rear of clamp places pressure on internally mounted captivated rubber gasket through which cable is passed. Angular walls of cavity containing gasket are designed to cause rubber to flow inward under pressure and to grip cable. Clamp can be used for both rigid and flexible coaxial lines or for radio leads and high or low tension lead-ins.—AVIATION, Aug., '46.

Insulating Material 74

Developed primarily as a jet engine cone-and-tail-pipe insulation and now in use in new jet planes, Refrasil mineral insulation material is announced by H. I. Thompson Co., Los Angeles, which was co-developer of product with Owens-Corning Fiberglas Corp., Toledo. Stated to withstand sustained temperatures of 2,000 deg. and flash peaks several hundred degrees higher with no loss of insulating efficiency, new material is said to be non-combustible, non-sustaining to fungi or vermin, and to have a negligible moisture absorption. It is supplied in batts of random lengths or in prefabricated blankets, boots, or covers.—AVIATION, Aug., '46.

Plug Gage 75

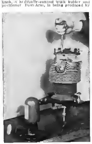
Designed to permit increased speed in gaging operations due to fact operator can approach work within 30 deg. of hole axis and still obtain alignment of piece part, also to permit gaging without loader drive on gaging member, new flexible plug gage handles are made by Sapphire Products Div., Elgin National Watch Co., Aurora, Ill. Handle is light to increase sensitivity.—AVIATION, Aug. '46.

Flareless Fitting 76

Developed for use in joining all types of metal tubing, including ½ hard stainless steel in hydraulic and fluid conveying systems, new flareless fitting made by Parker Appliance Co., Cleveland, is stated to eliminate need for special flaring and assembly tools, brazing or soldering. Fitting incorporates steel ferrule which, when body and enclosing nut are tightened, cuts a shoulder in tubing itself. It is expected to be useful in high pressure applications and in installations where thick walled tubing is used. In operation, cone angle of body contacts ferrule and directs it forward rear downward. Distortion of section in leading edge of ferrule permits deflection of extremity to afford camming contact for bite onto tube. Further tightening at specified torque forces ferrule into tube, casting up shoulder to resist pull out pressure. Fluid seal is also accomplished by compression of ferrule. Fittings are available in ⅛ to 1 in. o.d. tube sizes.—AVIATION, Aug. '46.

Work Holder 77

Featuring ability to hold jobs weighing up to 100 lb. in any position and to position work by adjustment of pressure control knob, a hydraulic-control work holder and positioner, PowrArm, is being produced by



Garfield Engineering Corp., Kansas City, Mo. Universal adapters available with unit permit mounting various types of work including generators, radio chassis, carburetors, airplane cylinder heads, castings, and machined parts. Operation is via hydraulic pressure applied to ball and socket joint.—AVIATION, Aug., '46.

Circular Slide Rule 78

Made to have accuracy of a 12-in. instrument, combined with pocket size convenience, new slide rule developed by American Hydromath Co., New York City, is of 4½ in. dia. Graduations are reproduced on facing surfaces and are protected with plastic lamination to correct for parallax error. Another feature is elimination of seldom-used scales. It has C and D scales, plus a log log scale ranging from 1.01 to 10⁸ which appears as an inner spiral of almost three turns. Unit is made from non-warping non-inflammable plastic, which is stated to be unaffected by moisture, perspiration or ink.—AVIATION, Aug., '46.

Grinding Fixture 79

Incorporating visual and external adjustments and being convertible to right or left hand operations, new axial relief grinding fixture, made by **Gevra Nelson Co.**, Detroit, has been developed to grind cutting edges, steps, flutes, and chip relief on milling cutters, burring tools, counterbores, end mills, reamers, drills, and taps. It can be used on surface grinders as well as cutter grinders. Axial relief is automatically equalized on flutes.—AVIATION, Aug., '46.

Ratchet Wrench 80

Incorporating 80-tooth action with mechanism encased in head measuring ¾ x 1⅝ in., ratchet wrench in new line made by **Duro Metal Products Co.**, Chicago, permits action in arcs of less than 5 deg. In these matched and balanced wrenches, drive sizes are ¼, ½ and ⅜ in. In each size proportioning of tool differs and point of balance is worked out accordingly. Finish is chrome plate with knurling on grip. Wrenches are made of hardened, tempered steel.—AVIATION, Aug., '46.

Flexible Shaft Grinder...................81

Developed by **Wyzenbeek & Staff**, Chicago, new flexible shaft grinder can be set on bench, hung from hook, or suspended from operator's belt. Three sizes are made—for light, medium, and constant duty in grinding, burring, filing, sanding or polishing. Motors are Universal a.c.-d.c. type with toggle switch in base. Flexible shafts have oil resistant synthetic rubber cover with non-metallic graphite impregnated inner liner. Hand pieces have ball bearings and interchangeable collets on all sizes.—AVIATION, Aug., '46.

Electrical Appliances

A.C. Generator 82

Featuring principle of electrical resonance for high voltage regulation, new a.c. generator, Regulectric, has been developed by **Electric Machinery Mfg. Co.**, Minneapolis, for use in engine generator sets. Built-in voltage-regulating circuit, designed to maintain voltage at power line quality, has no moving parts and is factory set to hold voltage within plus or minus 2½ from no load to full load with normal engine speed regulation. Generator is of revolving field type and is built in following ratings: 5 and 7½ kw., single phase, 1,800 rpm.; 7½ and 10 kw., three phase, 1,200 rpm.; 7½ and 10 kw., single phase, 1,800 rpm.; 10 and 15 kw., three phase, 1,800 rpm. All are 60 cycle. Connections required for non-parallel operation are leads from generator to load through generator switch.—AVIATION, Aug., '46.

Mounting and Sealing Nut...........83

Utilizing an elastic sleeve, new mounting and sealing nut, Sealnut, reported to prevent dirt, water, or gas from entering equipment panels around switch and control shafts, is announced by **Radio Frequency Laboratories**, Boonton, N. J. Base of nut is sealed to panel by internal rubber ring which permits metal to metal contact between nut and panel. Applications of nut include pressurized and moisture proof equipment, whether operating submerged or at high altitudes. Maker states it can be substituted for standard mounting nut on components of equipment now in service.

Electronic Gage Head...................84

Described as being complete within itself with minus and plus lights which operate within a gage setting of .0001, new electronic gage head for direct connection to 110v. current without use of transformers, is announced by **Yankee Precision Products Co.**, Hartford, Conn. Head can be attached to support or stand arranged to suit any specific application. Gage spindle is made to be frictionless, and contacts are stated to be made without multiplication leverage. Operation is through an electrical gas contact said to eliminate any tendency of contact sparking. Adjustment of setting is made by differential screw, and means are provided to lock setting. Unit is approximately 2¾ in. square.—AVIATION, Aug., '46.

Tagging the Bases

(Continued from page 50)

cabin with ropes, showed no signs of air sickness.

Third Region—An Aeronca Champion was shipped by C-47 from Dayton to Guatemala City, Guatemala, by Aviquipo, Inc. . . . Brecklin Air Service, Inc., is operating seaplane service at East 49th St., Cleveland . . . In recent meeting of more than 60 aircraft service operators at Galesburg, Ill., Illinois Airport & Operators Assn. was formed with Arthur Curry, mgr. of Galesburg Municipal Airport, elected pres. . . . In DuPage county the Air Power Club and CAP are working for air markers in county, public celebrations of special aviation days, model airplane meets, and technical advice to airport managers, flying clubs, airplane owners, and pilots . . . Sportsman's Flying Service now has airport in heart of Michigan fishing area, halfway between Alpena and Gaylord, and 23 air miles North of Mio. Cabins are available with transportation to restaurant and flying field. Bob DeLeull is pres. of service and George Roth, sec.-treas. and mgr. . . . Ray Snyder, president of Snyder Aircraft Corp., Chicago, suggests NATA inform service operators how re-arranging traffic patterns and setting up strict field rules will minimize aircraft noise over residential areas.

Fourth Region—Southwest Airmotive Co., Love Field, Dallas, is acting as southwestern U. S. distributor for Jacobs Aircraft Engine Co.; also represents Pratt & Whitney, Wright, Lycoming, and others.

Fifth Region—In Argonia, Kan., one street leading directly from airport into downtown district has been set aside for use as a plane taxi strip with cleared space for parking . . . Model Airpark, recently dedicated and opened at Eldon, Mo., for private flyers is seen "showing the way." Field is leased to Associated Airports, Inc., Kansas City, headed by Edgar Smith, pres. Harold Carroway is resident mgr. Operator has agreed to maintain government approved flying school charter and plane rental service and maintenance and repair service . . . Operators of flight schools, airports, charter services, and aircraft sales or-

ganizations recently met in St. Louis to form The Greater St Louis Aviation Operators' Assn., including all phases of aircraft operations except scheduled lines Clyde E Brayton Braylon Flying Service, was elected president

Seventh Region—Portland Ore. will soon have combined sea and air base in Columbia River alongside Jantzen Beach with 30 x 60 ft. float for seaplanes Gard Safley is developing the $500,000 project . . . For first time since its completion Seattle-Tacoma airport at Bow Lake is being used for practice landings by private aircraft to relieve congestion at Boeing Field . . . Peter Vanguard who heads Vanguard Inc. manufacturer of jams, jellies, and extracts, has begun a $1,000 000 air "Sky life" country club, to be located 15 min. from downtown Portland, Ore., and to provide housing for fully 500 airplanes . . . Several Seattle aircraft distributors are planning establishment of sub assembly plants Washington Aircraft & Transport Corp., distributor for Stinson and Aeronca, has received and assembled its 7th carload of planes and plans to establish a large assembly shop

Canada—New facility for floatplanes has been built at Toronto Island Airport . . . Air Cruise from Toronto to Algonquin Park will be held Sept. 18-21. meeting in Toronto Sept 18

Personal Plane Design

(Continued from page 75)

sea level rating

$$hp_1 = hp\ \sigma^{1.20} \qquad (2.15)$$

which can then be used in the same formulas for anything at or above critical altitude

For those who don't like exponents, Eq (23) is a convenient substitute. It will be noted from Fig. 1 that this straight-line representation is actually a closer fit for most of the points than the original power function. The final choice will usually depend on the kind of further mathematical work in prospect

For preliminary studies of a new design, the representative propeller here defined can be used, or any other type of design which may be preferred and for which equivalent data are known. Here it should be noted that the term 'representative propeller' means not a specific propeller of a given diameter turning at a definite rpm., but a family of propellers similar in planform, section, and number of blades which can be used in whatever way and with whatever engine power appears advantageous for the various purposes in mind. It is in this stage of the design that formulas, such as here presented, are most obviously profitable.

A final observation may be made with respect to the scatter of experimental points, particularly noticeable in Fig 3. Here not only must original experimental error be contended with, but also observational error in the fairing and interpretation of the curves and in picking the true peak of each gradually rounded top. The correlation of propeller data is notoriously difficult, and it appears quite possible that the smooth curves based on mathematical equations through the average of the points may be fully as close in representing the true values as the points themselves. This could never be assumed under conditions imposing sudden stalling or other sharp irregularity, but such conditions mainly are prevalent at speeds below those of interest in connection with flight performance

It may be concluded that the equations here presented, in their more general form, are good to a close order of accuracy for all flight performance conditions normally applicable to personal planes. In addition, the equations for representative propeller design permit quick estimates of actual performance and the effect of major variables, as will next be shown by simple applications to practical performance objectives

Flying Service Promotion

(Continued from page 49)

tion, descriptive literature provided by airplane manufacturers was used in conjunction with the marketing of all new craft

The average new operator will most likely represent the smaller type of operation. Here an attractive and well-arranged general descriptive folder can be used to advantage.

It is logical to believe that the person who comes to the airport has some interest or curiosity regarding aviation, or he wouldn't be there. Thus, the initial step should be to contact every visitor at the airport and at its parking lot. Consistent effort should result in few people leaving the field who have not been given a folder, invited to inspect the planes, and asked whether or not they would like to fly. The visitor can be sounded out for something more than just a short flight. Suggestions can be proffered for a more extensive air tour, or, better still, a trial flying lesson. A trial at the controls can be offered with a dollar flight, or free demonstrations may be offered on a selective basis. With the lightplane, much can be done in the way of demonstrations at low cost.

Selling the Short Flight

Basic service of flying operations has been the short flight. "Barking rides" is a phrase that has accompanied the sale of the short flight since the early days of aviation. In some places a good short-flight business can still be done. The field salesman should make a digni

full approach and give the prospect some information about the flight. This may not be easy to do at a time when there is a steady stream of riders. Then it is usually a matter of keeping them coming in a smooth flow. However, in many of the smaller setups, this will not be the case too frequently.

For the short flight, the rider should be accorded the same service and assistance on the field and about the plane as would be given a customer spending many times that amount of money. Here the operator can profitably take a page from airline courtesy (and this applies to all of his public relations). Pilots should be more interested in the enjoyment of their passenger than in a display of skill. The pilot might ask his passengers what they would like to see, suggest points of interest, and be ready to explain items about the airplane and its flight. After flying, the customer should be asked if he enjoyed the trip, and an invitation to return should be extended.

Real importance of the short flight is that it frequently is the average person's introduction to flying. Some operators estimated, as late as 1939, that at least two-thirds of their riders were first-comers. Where it is a first flight it is likewise a first impression, and first impressions are frequently lasting. Hence, it is evident that everyone should carry out the short flight so as to give the best possible impression of flying. The operator must always keep in mind that the flight may well be the stepping stone to a new student account, and eventually an airplane sale. The writer can recall several cases of individuals who came to the airport to "just look," were sold a short flight, then learned to fly, and eventually became owners. Certainly, this is a profitable sequence of events.

A-Bomb vs. Surface Ships

(Continued from page 41)

lionth of a second. This dazzling photo-flash didn't melt even the thinnest aluminum foil or appreciably warm the ships. It merely gave them a skin-deep sunburn. Top paint coats were blistered, lower coats were untouched.

Very likely the instantaneous pressure at the center of the bomb reached millions of pounds per square inch, but again distance did its work. On the cruiser *Pensacola*, approximately one-third mile from the burst, blast pressure was only 5 or 10 psi., which would be enough to account for the collapse of the approximately 20 ft. wide by 30-ft. high tunnels of thin gage-steel. At 10 psi. the total force on the projected area of one stack would be over 400 tons.

The bomb produced approximately the same blast, flash and radioactivity as the one that burst over Nagasaki. But the much stronger construction of naval targets contracted the circle of great damage from about a 3-mi. diameter to about 1½ mi. Moreover the space within the smaller circle was mostly open water, not a solid mass of structures as in a city.

Atom bombing a fleet is something like atom bombing a community of small farms where each farm house (ship) is heavily built of reinforced concrete.

Before this test it was obvious that a fleet could be so disposed that no atom bomb could sink more than one ship. Now admirals will know just what spacing of ships at anchor or in motion will achieve this one-bomb-per-ship situation for ships of given type and construction.

The position and height of the burst will not be revealed, but guessing is permitted. From my observation of flash shadows, I estimate that the burst was 400 to 600 ft. in the air, about 1,200 ft. astern of the *Nevada* and slightly on the port side.

All the damaged ships I inspected showed the effect of a moderate blast pressure rather evenly spread over vast areas. Heavy structures, such as big funnels and turrets, were unscathed. More flimsy constructions, such as thin wind breaks, funnels, topmasts and radio masts, were often bent and twisted. At one-third mile, or even less, rubber tires remained like new and exposed jeeps could have been driven away. On the other hand, many airplanes on decks at greater distances were substantially damaged by blast pressure. Lest all this sound like belittling the Able Day bomb, let me point out that it did immensely more damage than any other in naval history, that it sank five ships, heavily damaged five others.

Of the unsunk ships, only the *Independence* showed any hull damage, and that well above the water line. She was thoroughly smashed topside. Damage to the heavily built *Nevada* was all topside and moderate. Heavy construction was not affected. Thinner plates exposed to the blast and not well braced were often bent or loosened. On ships within a ½ mi., topmasts, radio masts and funnels were often damaged.

Considering material damage to the ships as distinct from the effect of radioactivity on life aboard, I would assess the damage to well-built war ships from an air blast of this type about as follows in terms of distance from the blast: 1 mi., practically no damage; ¾ mi., slight damage; ½ mi., moderate damage; ¼ mi., heavy damage; somewhere between 3/16 and ⅛ mi., sinking. There appears to be little hull damage beyond ¼ mi.

As to the protection of the men aboard ships, I would expect special clothing could protect the crew from injury by heat flash wherever distance would save

the ship and crew from the blast. I doubt that similar protection can be provided against radioactivity. There the difficulties are great and no final answer can be given until the reactions of the experimental animals have been fully studied.

Men on ships exposed to atom bombs would receive tremendous doses of radioactive rays, including the penetrating gamma rays that retain 10% of their strength even after traversing 2 in. of solid steel. Moreover, the immediate survivors of the blast would be living in a radioactive ship where even the table salt, the food and the soap would be dangerously radioactive. Careful, long-term observation of the exposed animals can show at what distance ships' crews exposed to radiation might be permanently safe, and at what shorter distance they might live to finish a battle, although as men marked for certain death.

It is clearly impracticable to design a ship or protect a crew for survival under direct hit or near miss of an atomic bomb. But the Navy must soon decide for each class of ship what is the survival distance for the ship and crew as an operating unit. Such studies will inevitably lead to marked changes in ship design and operation.

Some have said the tests are a waste of money because a Navy will be useless in an atomic war, since rockets can attack directly across oceans. Personally, I don't think the time has yet come to junk the Navy.

But two facts have now been clearly demonstrated: The atomic bomb (and rocket) is the most effective weapon ever devised against ships. It is even more effective for the area bombing of cities and of concentrated industrial areas. The kind of bomb that failed to rip the leaves from the palms of Bikini Island can still destroy civilization if atomic war comes.

Profits Balanced

(*Continued from page 52*)

train can haul in the same period. Stockholders, he feels, should know that in contrast to the dominant position occupied by Douglas prior to the war, several other large manufacturers have emerged with extensive facilities and working capital who are out after a portion of the limited commercial market.

He also points out that the cost of bringing out a new model has risen from a few hundred thousand dollars in the 1930s to a major undertaking of several million dollars. And at the same time technological advances are so rapid that new models may become obsolete before quantity production is reached.

Pres. William M. Allen of Boeing feels much the same way about the outlook. There has been a buyer's market in both military and commercial fields, he comments, which may continue for a substantial period of time. These days, he points out, it is necessary to invest millions in the development of a new model without any certainty that quantity orders will be forthcoming. Yet he believes Boeing has planes today that will sell and that other models will be developed that will be equally outstanding.

Boeing recently had a backlog of \$130,000,000, yet 1946 deliveries will be fairly small. Material shortages have delayed production at least three months. The result will be that 1946 business will consist mostly of completing the B-29 order and one or more of C-97 Army cargo planes.

Scheduled for 1947 delivery are sixty of the B-50 bombers, the Stratocruiser, of which more than 40 are on order from airlines, and the 417 twin engine feeder-line plane.

Boeing may not charge off against profits all development and tooling expense incurred this year. This would aid materially in the reporting of a moderate profit for 1946. Substantially all new military and commercial contracts are being entered into on a fixed price basis.

Consolidated Vultee has \$200,000,000 in unfilled orders consisting of twelve different types of planes in production or in advanced stages of development. But despite this impressive backlog, Convair probably will sustain a substantial loss from operations this year.

Development and tooling costs will be heavy, for one thing, while delivery of the greater portion of unfilled orders will not take place until 1947. The majority of military contracts, it is understood, are on a cost-plus-fixed-fee basis which limits profits on such orders. Furthermore, strikes of several weeks duration at four different plants have had an adverse effect on current earning power.

Consolidated has a growing stake in a wide range of such non-aviation products as ranges, farm equipment and buses but as these items represent new ventures it is hard to determine how soon they will contribute materially to earnings. Meanwhile, the company continues principally as an aircraft manufacturer.

Commercial business consists of orders for 120 of the forty passenger 240s and a number of the larger Convair 37 transport. A prototype of the 240 probably will fly next December with deliveries scheduled next year. Construction of the 37 awaits the development of suitable engines.

North American Aviation Inc. has a backlog of \$75,000,000 in government orders, including the largest amount of

experimental business in its history. But production orders are small in contrast to its wartime volume and 1946 earnings will result largely from profits on terminated contracts and tax carry-backs.

Production contracts are held for the P-82 Twin Mustang and a secret Navy plane as well as development contracts on four new military types.

Outside of the military field, North American is flying an all-metal four-place family plane called the Navion. First deliveries of this personal plane are scheduled for September with production reaching a 200 a month goal shortly thereafter.

Having shown net income of only $38,000 in the seven months to Feb 28, it is not likely that Northrop Aircraft Inc. will report anything more than very moderate profits for the fiscal year which ended July 31. However, company officials look for "satisfactory" earnings next year and look to the company's subsidiaries to stabilize earning power.

These subsidiaries include Salisbury Motors, Northrop Foundry, both wholly-owned by Northrop, and Northrop-Hendy Co., jointly owned by Northrop and Joshua Hendy Iron Works.

Northrop has three major aircraft projects underway. Besides the XB-35 Flying Wing long-range bomber, a cargo plane called the Pioneer is under development and production is progressing on the Reporter, a photo-reconnaissance plane based on the P-61 Black Widow design.

Unfilled orders total $53,000,000 for these planes plus some research jobs. The company hopes to finance its peacetime work without resort to increased capitalization and is counting on excess profits tax refunds to provide considerable additional working capital.

Hyperbolic Radio Avigation

(*Continued from page 51*)

signal simultaneously, and the measurements made entirely automatically. With loran, two independent measurements are necessary, one for each of two pairs of master and slave, each master having but one slave as shown in Fig 1B. The speed with which readings can be made with gee and decca are offset by the possibility of the pilot manually choosing two loran pairs that give a more orthogonal set of lines of location at the fix, thereby obtaining optimum geometric accuracy.

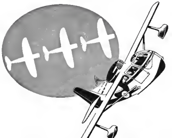
The method of timing the arrival of the signals by comparing pulses, used in loran and gee, gives an unambiguous determination of line of position. However, such a technique cannot measure time differences that are appreciably shorter than the pulse length, so its timing accuracy (that is, the accuracy with which one can measure the difference in arrival time of two signals) is limited. Furthermore the length of the pulse is determined by the radio carrier frequency, it being necessary to use longer pulses at lower carrier frequencies. The high frequency at which gee operates was chosen to permit the use of short pulses, thereby obtaining high timing accuracy.

The length of the base line, and hence the geometric accuracy of a system is determined, for the most part, by the radio frequency of the carrier. For example, because at two megacycles at which ss-loran operates it is possible to transmit over great distances at night by taking advantage of the reflection of the radio waves from the inosphere, a long base line is obtained. At the higher frequencies of gee and the lower frequencies of lf-loran and decca, it is not possible to transmit such great distances, therefore the systems are limited to base lines of hundreds of miles.

Thus, although the timing accuracy of a pulse system can be excellent at high carrier frequencies, the geometric accuracy is poor, the geometric accuracy and the timing accuracy are both good at intermediate frequencies, and at low carrier frequencies both the timing and geometric accuracies of a solely pulse-timed system are poor. Because of this last feature, other methods of comparing time differences are used for systems such as lf loran and decca which operate at low radio frequencies. The method is similar to that used in the frequency modulated altimeter, whereas loran, ss-loran and gee use techniques comparable to those of the pulse altimeter.

Decca compares the difference in phase produced by the differential distance traveled by the signals. However, three signals in groups of two can produce the same phase difference along many lines of position, thus unless one knows his approximate position, he cannot rely upon decca. This objection is most serious in cases where one flies into the service area of a decca chain and must determine the correct lines of position on which to start the equipment operating. The number of ambiguous lines of position can be very much reduced by adding a third slave to each decca chain, if the increased complexity of the equipment can be tolerated.

By using a similar technique, called "cycle matching", a very high accuracy can be obtained with lf-loran. Ambiguity is avoided by first comparing the times of arrivals of the necessarily long pulses of this loran, thereby first obtaining an approximate position. Then the individual cycles of the radio frequency carrier are made to coincide giving a very accurate determination of the interval between the arrival of each signal.



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Effective July 15, 1946, the list price of the standard Republic Seabee becomes $4495 ◖ The original figure announced late in '45, was based on sound evaluations of man hour and material expenses Since V-E Day, mounting costs of every part . . . innovations in the plane itself . . . and the voluntary raise in wages by Republic to meet increased living needs, are the sole reasons for this new price ◖ The four-place Seabee amphibian is of all-metal construction, including wing and control surfaces. It is built by the makers of the mighty Thunderbolt, to standards of ruggedness and performance which would cost thousands more if it were not for Republic's simplified methods of design and manufacture. ◖ Of prime importance to the owner, we have refused to consider any compromise with standards of material or workmanship. Hence, despite the modest increase, this versatile airplane is without question the unparalleled buy which all acclaim as the outstanding value for 1946-47.

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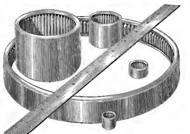

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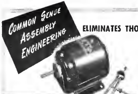

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BY QUESTIONING FASTENINGS

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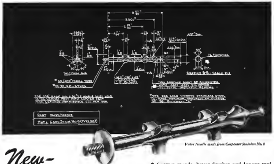

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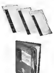

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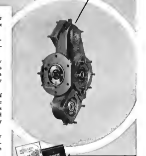

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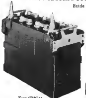

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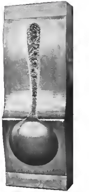

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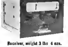

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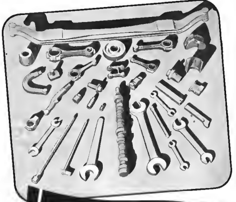

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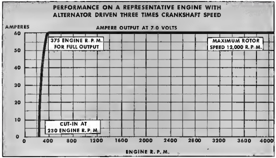

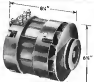

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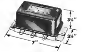

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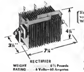

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INCREASED facilities for research into all uses of petroleum and its products will be provided in Sinclair Oil Corporation's elaborate new research laboratory planned for Harvey, Illinois.

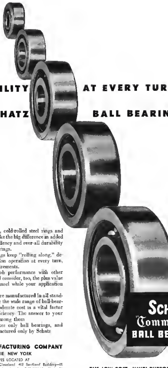
In this most modern of laboratories, recognized experts in petroleum technology will further the development of new and improved aviation fuels and lubricants to keep pace with the rapid expansion of present-day flying.

For over 15 years, Sinclair has pioneered in the development and manufacture of high quality aircraft engine oils and other aircraft lubricants With the opening of the new research center, Sinclair will be in an even better position to cooperate in and promote the advancement of aviation in all its fields

SINCLAIR AVIATION OILS

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE NEW YORK 20, N. Y.

EXTRA-UTILITY AT EVERY TURN WITH SCHATZ BALL BEARINGS



High grade, low-carbon, cold-rolled steel rings and through-hardened balls make the big difference in added load-bearing capacity, resiliency and over-all durability of "Commercial" ball bearings.

That's why these bearings keep "rolling along," delivering efficient anti friction operation at every turn, whatever the service requirements.

Compare their on-the-job performance with other low-cost ball bearings And consider, too, the plus value of Schatz engineering counsel while your application is in the design stage.

Schatz "Commercials" are manufactured in all standard types and sizes to cover the wide range of ball-bearing applications where moderate cost is a vital factor alongside of maximum efficiency. The answer to your anti-friction problem is among them

Remember, Schatz makes only ball bearings, and "Commercials" are manufactured only by Schatz

SCHATZ "Commercial" BALL BEARINGS

THE SCHATZ MANUFACTURING COMPANY
POUGHKEEPSIE NEW YORK
REPRESENTATIVES LOCATED AT
Detroit 2640 Book Tower—26 • Cleveland 402 Swetland Building—15
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THE LOW-COST, MULTI-PURPOSE BALL BEARING

SURE, YOU CAN DESIGN IT...

... BUT CAN YOU MAKE IT OF STAINLESS STEEL?

It's one thing to design stainless steel parts or equipment and quite another to produce them ... as many manufacturers have discovered in the past.

But today products that require the corrosion and heat resistant properties of stainless ... small, intricate parts, large sheets with complex curves and bends ... can be fabricated to amazingly close tolerances by Solar's exclusive Sol-A-Die Process.

SOLAR has mastered the difficulties of working stainless steel to the point where it is now possible for many industries to employ the outstanding properties of this modern material. If your engineers have had fabricating difficulties with stainless steel, remember that Solar's new techniques and skills can solve your problems. Consult Solar about *longer lasting* stainless steel parts (or equipment) now.

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SOLAR
STAINLESS PRODUCTS

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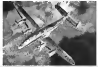
The record-breaking performance of Lockheed's great CONSTELLATION has made it a world-wide favorite on leading commercial airlines. Passengers who seek accommodations on CONSTELLATION flights do so with the knowledge they will get a fast, comfortable trip in a well-appointed airplane. Cabin temperatures are automatically controlled by Barber-Colman equipment. These controls are specially designed for aircraft service — they are light, accurate, powerful, durable, and give reliable performance with a minimum of service. Barber-Colman Controls are fully electrical, and are unaffected by changes in altitude, cabin pressure, or attitude of the airplane. Barber-Colman Controls for Aircraft are available in wide variety and are easily engineered to meet the requirements of all types of aircraft systems and construction. *Ask for full details.*



LOOK FOR BARBER-COLMAN CONTROLS ON THE LEADING LUXURY AIRLINERS

BARBER-COLMAN COMPANY
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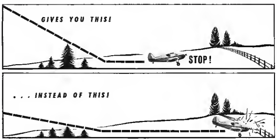
EMERGENCY!

NEW SAFETY LANDING DEVICE

provides

STEEPER DESCENT ANGLE • SHORTER LANDING ROLL



Aircraft Devices Co announces a new safety landing device for installation in light planes, with or without flaps! The device is a stabilizer and will permit the pilot, in case of an emergency, to land in a short field in complete safety!

With the stabilizer, which works manually from the fuselage to the rail, the pilot is able to come in at a steeper angle of approach without danger of stalling and can apply his brakes much more sharply than formerly so as to stop in a considerably shorter run This permits the pilot to land where he wants to, and eliminates the hazard of trees and telegraph lines which usually block emergency landing fields

The device is a completely new departure in the personal plane field—*is patented and CAA approved!*

FEATURE The stabilizer does not alter the flight characteristics When not in use, you don't know it is in the plane!

FEATURE Inexpensive first cost—simple installation—practically no maintenance!

FEATURE Manually controlled—lightweight!

FEATURE Tends to prevent nosing over due to mud, snow or other conditions

We urge manufacturers and owners of small planes to ask us for full details Write today

AIRCRAFT DEVICES COMPANY

Wings Field . . . Ambler-Pennsylvania

U S S SHELBY Seamless Aircraft Tubing helps to give greater safety, performance and comfort to the sportsman pilot.

There can be no compromise with safety in aircraft construction—no substitute for predetermined reliability. Here is another reason why Aeronca and many other plane builders are selecting SHELBY—they know they can depend on it. The finest tubing produced for the aircraft industry, SHELBY Seamless is made to exacting government specifications is available in a complete range of sizes and in the current alloy steels.

Here again Shelby Aircraft Tubing assures light weight, strength and safety

"A RUGGED, dependable plane that's equal to any task you put it to," that's what the makers say about the new Aeronca "Champion" And they have sound reasons for their claim.

For, although this personal plane is a new postwar model Aeronca and was introduced only last September, its structural framework of SHELBY Seamless Aircraft Tubing is the same construction that made the Army's Aeronca "Grasshoppers" outstanding for sturdiness

It is because SHELBY Seamless Tubing keeps weight to the very minimum and yet insures the utmost in ruggedness and shock-absorbing qualities that SHELBY has found such favor with aircraft designers With no other type of construction can you build aircraft so strong, so light in weight and so durable, as is possible by using seamless steel tubing

Whether you are building personal planes, helicopters, fighters, flying freighters, passenger transports or airships, SHELBY Seamless Tubing—in longerons, fuselage struts, wing spars, tail assembly, engine mounts and landing gear—will help achieve the utmost in structural efficiency

Its uniformity and dimensional accuracy, its ability to bend and shape to almost any form desired, its easy welding properties that permit complicated joints and junctions with 100% efficiency, enable you to take full advantage of the latest improvements in plane design and fabrication techniques. Our engineers will gladly cooperate with you in applying U S S SHELBY Tubing most economically

U·S·S SHELBY SEAMLESS *Aircraft Tubing*

NATIONAL TUBE COMPANY

PITTSBURGH, PA

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UNITED STATES STEEL

HOW ARE YOUR TIRES?

Here is an outstanding opportunity to purchase aircraft tires and tubes at substantially reduced prices. The War Assets Administration has, *in stock*, a wide variety of casings and tubes made for every type of aircraft used by the Armed Forces from small liaison to large cargo planes.

This enormous stock of government-owned surplus represents both unused and used tires and tubes. They are offered in a broad range of sizes, treads and cords for both landing and auxiliary (tail and nose) equipment.

These tires and tubes are suitable for use on airlines, cargo carriers or privately owned planes. Every order will receive careful attention regardless of its size.

These tires and tubes are *low priced* for immediate disposal. Check your needs *now!* Then place your order detailing complete specifications so that price and delivery can be quoted.

If you are located west of the Rockies, address your inquiry to:

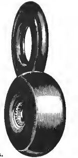
WAR ASSETS ADMINISTRATION
155 W. Washington Boulevard
Los Angeles 15, California

If you are located east of the Rockies, address your inquiry to:

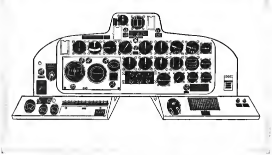
WAR ASSETS ADMINISTRATION
National Aircraft Components Sales Center
6200 Riverside Drive
Municipal Airport
Cleveland 32, Ohio

OR

WAR ASSETS ADMINISTRATION
Office of Aircraft Disposal
425 Second Street, N. W.
Washington 25, D. C.



Veterans of World War II:
Veterans may use their priorities in buying these tires and tubes.



AIRCRAFT INSTRUMENTS

Plane owners, Airline and Fixed Base Operators—if you are interested in purchasing aircraft instruments, the War Assets Administration has a quantity of precision equipment for sale.

This inventory consists of turn and bank indicators, altimeters, gyro horizons, rate of climb indicators, gyro and magnetic compasses and airspeed indicators. There is also a considerable number of engine instruments available.

Designed to attract the prudent buyers, these units are price-scaled according to condition. Many are usable without repairs—others are usable after repairs.

A large supply of type C-3 Link-Trainers in usable and repairable condition are also for sale at attractive prices.

You are invited to detail your requirements so that prices and delivery information may be quoted.

You are urged to contact the WAA Authorized Agent nearest to you. However, if this is not convenient the following WAA offices will be glad to serve you.

If you are located west of the Rockies, address your inquiry to:

WAR ASSETS ADMINISTRATION
155 W. Washington Boulevard
Los Angeles 15, California

If you are located east of the Rockies, address your inquiry to:

WAR ASSETS ADMINISTRATION
National Aircraft Components Sales Center
6200 Riverside Drive, Municipal Airport,
Cleveland 32, Ohio **OR**

WAR ASSETS ADMINISTRATION

OFFICE OF AIRCRAFT DISPOSAL
425 Second Street, N. W., Washington 25, D. C.

***Veterans of World War II:* Veterans may use their priorities in buying these aircraft instruments**

595

PROPELLERS

The War Assets Administration has available government-owned surplus aircraft propellers in various models and specifications. These propellers were built by well-known manufacturers of aircraft components to the specifications of the Armed Forces. They are adaptable to planes ranging from light planes to large transports and are eligible for CAA Certification.

Attractively priced for immediate sale, it will pay you to check your requirements *now!*

If you will send your inquiry stating model and detail specifications, prices and delivery information will be forwarded promptly.

You are urged to contact the WAA Authorized Agent nearest to you. However, if this is not convenient the following WAA offices will be glad to serve you.

If you are located west of the Rockies, address your inquiry to:

WAR ASSETS ADMINISTRATION
155 W. Washington Blvd.
Los Angeles 15, California

If you are located east of the Rockies, address your inquiry to:

WAR ASSETS ADMINISTRATION
National Aircraft Components Sales Center
6200 Riverside Drive
Municipal Airport
Cleveland 32, Ohio

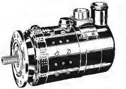
OR

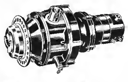
WAR ASSETS ADMINISTRATION
Office of Aircraft Disposal
425 Second Street, N. W.
Washington 25, D. C.

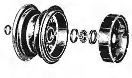
Veterans of World War II: **Veterans may use their priorities in buying these propellers.**

MISCELLANEOUS PARTS AND EQUIPMENT

Government-owned surplus in aircraft has produced a quantity of spare parts and equipment both unused and usable with repairs.







In this inventory are listed such items as: magnetos, motors, generators and other electrical accessories. Various types of wheels and brakes, carburetors and carburetor parts, fuel, oil and hydraulic equipment, miscellaneous engine accessories.

From this store of material you will probably find the things you need to keep you flying. Send your inquiry including specifications on just what you want. Prices and delivery information will be sent to you as speedily as possible.

You are urged to contact the WAA Authorized Agent nearest to you. However, if this is not convenient the following WAA offices will be glad to serve you.

If you are located west of the Rockies, address your inquiry to:

WAR ASSETS ADMINISTRATION
155 W. Washington Boulevard
Los Angeles 15, California

If you are located east of the Rockies, address your inquiry to:

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425 Second Street, N. W., Washington 25, D. C.

Veterans of World War II:
Veterans may use their priorities in buying these miscellaneous parts and equipment

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***"Tailor-Make"* Your Adjustment**

Push it back or forth; up or down. Extension 14" to 22".

Hindview **Mirror**

Ball and socket joint has built-in spring tension.

Illustration shows one truck-model mirror at 3 angles, 3 lengths.

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STEEL CONSTRUCTION				WOOD CONSTRUCTION			
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(Prefabricated steel hangars available soon)

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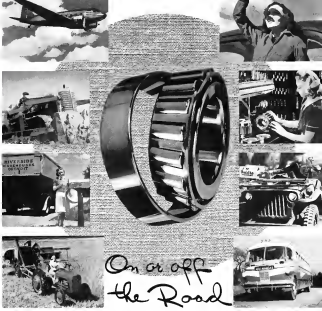
CLASSIFIED DISPLAY ADVERTISERS



NORTON

TELLS INDEPENDENT INVESTIGATOR

"No more burrs, breaks, or skids when we set 'em-up solid!"

"SCREW TIGHTNESS IS A 'MUST' in our machines, to eliminate vibration. We have to set-em-up to the limit, which means a heavy torque load on the screwhead. With slotted screws this meant burrs, breakage, or driver skids, but the Phillips head can take it."

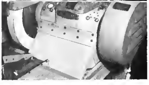
"PHILLIPS SCREWS ended our former troubles with slotted screws", Norton officials told the investigator from James O Peck Co, industrial research authorities His study of assembly methods at Norton Co., world renowned manufacturer of precision grinding machines, is one of a series being made in representative plants using Phillips Screws

"BURRS CAN'T BE TOLERATED in a good machine tool," said a Norton engineer "First, they reflect on workmanship and quality. Second, they'd threaten injuries to operators by snagging waste used in wiping. When heads burred or broke, they had to be removed and replaced, wasting time.

"DRIVER SKIDS WERE ALSO FREQUENT with slotted screws, because of the extra pressure, causing injuries to hands banged against adjacent parts.

"WITH PHILLIPS SCREWS, we've ended burring, breaking, and driver skids. The driver stays in the recess, with any pressure. Starting in any position is easier, quicker – driving is faster."

GET THE COMPLETE REPORT. With other reports now ready on leading manufacturers' savings with Phillips Screws, and more to come – covering products of metal, plastics, wood – it affords a practical manual of modern assembly methods. Get these inside facts – worth good money – FREE to you – Fill out and mail the coupon TODAY!



PHILLIPS SCREW MFRS., c/o Horton-Noyes 8
2300 Industrial Trust Bldg., Providence, R. I.
Please put me on the list to receive all reports on Assembly Savings with Phillips Screws

Name ______

Company ______

Address ______

PHILLIPS *Recessed Head* SCREWS

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

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The Southington Hardware Mfg. Co.
The Steel Company of Canada, Ltd
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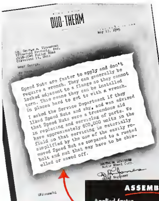
DUO-THERM

May 17, 1945

Mr. George A. Tinnerman
Tinnerman Products Inc.
2038-2046 Fulton Road
Cleveland 13, Ohio

Dear George,

Speed Nuts are faster to apply and don't require a wrench. They can generally be locked adjacent to a flange so they cannot turn. This means they can be installed in places hard to get to with a wrench.

I asked the Service Department if they liked Speed Nuts and why, and was advised that Speed Nuts were a tremendous aid in replacing and servicing of parts. We have approximately 600,000 units in the field so that servicing is materially simplified by the use of the easily removed Speed Nut as compared to a rusted bolt and nut that may have to be chiselled or sawed off.

SOUTHERN DIVISION
Motor Wheel Corp.

Chief Engineer

DFJones/bl

Let SPEED NUT USERS *tell you why* They Changed to SPEED NUTS

No. 2 in a series, "The Customer Talks"

ASSEMBLY ADVANTAGES

- Applied faster
- Will not "freeze" to threads
- Will not "clog" with paint
- Reduce assembly costs
- Eliminate lock washers
- Eliminate handling of material
- Perform multiple functions
- Weigh less
- Prevent vibration loosening
- Protect fragile materials against damage

Let Duo-Therm's Chief Engineer, D. F. Jones, tell you what *he* thinks. His letter above leaves no doubt about the advantages of SPEED NUTS in the manufacture and servicing of hundreds of thousands of fuel oil heaters by the Duo-Therm Division of Motor Wheel Corporation.

SPEED NUTS help keep down the costs on Duo-Therm's modernized assembly lines. And the ease with which SPEED NUTS are removed greatly speeds up servicing their units in the field.

Why postpone the improvement of your product assembly? Eliminate waste motions, unnecessary parts and useless weight by changing to SPEED NUTS. Send your complete assembly details when writing for samples as SPEED NUTS are made in over 3,000 shapes and sizes.

TINNERMAN PRODUCTS, INC. • 2070 FULTON ROAD, CLEVELAND 13, OHIO

In Canada: Wallace Barnes Co., Ltd., Hamilton, Ontario
In England: Simmonds Aerocessories, Ltd., London
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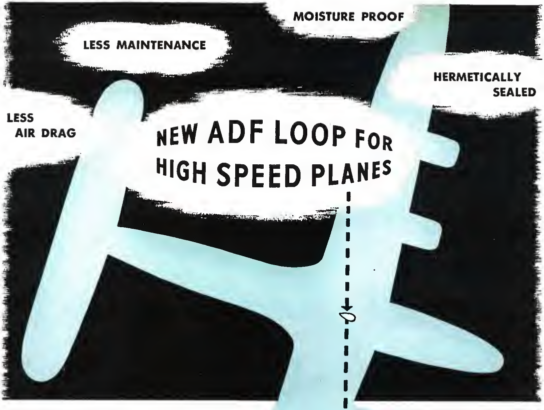
Speed Nuts* PATENTED *Trade Mark Reg. U. S. Pat. Off.

FASTEST THING IN FASTENINGS



Developed by Bendix engineers to increase aerodynamic efficiency, the type MN-60A Iron-Core Loop reduces air drag to only 2.57 pounds at 300 mph. Use of the iron core permits reduction in size, while retaining the signal pickup efficiency of larger loops.

All moving parts are hermetically sealed in dry nitrogen, eliminating oxidation and minimizing maintenance problems The Type MN-60A loop assures thousands of hours of trouble-free operation

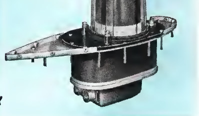
A low-inertia a-c induction motor rotates the loop. A combined quadrantal error corrector and "Autosyn" transmits corrected bearings accurately to a remote indicator

A streamlined phenolic-impregnated anti-static housing is available for belly or top mounting

Write for new brochure, "Toward Automatic Flight."

BENDIX RADIO DIVISION, BALTIMORE 4, MD.

MN-60A
IRON CORE LOOP



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